THE

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THE

UNIVERSAL ELECTRICAL DIRECTORY

1901 Edition

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THE BOARD OF TRADE AND THE ELECTRIC SUPPLY TARIFF.

THE Board of Trade has notified its intention of modifying the price schedule in future provisional orders so that an unqualified price of 8d. per unit will no longer be admissible in the fourth schedule.

Now as the result of extended experience in many towns, both large and small, it has been found that from 10 to 20 per cent. of the consumers cannot, owing to the short period and incidence of their consumption, be profitably supplied at 8d. per unit, if the price to them works out at less than this, it follows that the loss incurred must be made up out of the payments from the general body of consumers, and more especially from the smaller shops and private houses in which artificial lighting is used pretty regularly throughout the year, and for many hours each day.

The great future for electric lighting is among the rows upon rows of small private houses which are numerous and increasing in the suburbs of most of our towns, and in the homes of the working classes, where it will be especially welcome; but unless the loss on the short-hour users is avoided by means of an equitable tariff, progress in this direction will be seriously retarded.

It is, of course, necessary that provisional orders should contain some restrictions in regard to price, but a little consideration will show that such restrictions can be most effectively imposed upon the general average price.

This can be dealt with in an equitable form, to comply with the new requirements of the Board of Trade, under the "maximum demand" basis of charging, which was approved by Parliament in connection with the Electric Power Bills of last session, and the following clause has been suggested for the purpose by the London Chamber of Commerce:—

"Where undertakers charge any consumer by the actual amount of energy supplied him, they shall be entitled to charge him at the following rates per quarter:—

"For any amount up to 20 units, 13s. 4d., provided that if, in any one year after the first complete year of working, the general average price of electrical energy for all purposes under the order exceeds d. per unit, then, for the following year, a reduction shall be made equitably calculated to bring such general average price down to d. per unit."

In towns under 20,000 inhabitants a *general average price* of 6d. per unit is desirable, in towns over that size or in exceptional districts a general average of 5d. will prove sufficient.

The following alternative clauses have also been suggested to meet the requirements of the Board of Trade, and to comply at the same time with the practical conditions of electricity supply work:—

"Where the undertakers charge any consumer by the actual amount of energy supplied to him, they shall be entitled to charge him at the following rate per quarter:—

"(*a*) For any quantity up to 20 units, 13s. 4d.

"(*b*) For any quantity not exceeding the equivalent of 100 hours of supply at the maximum power which has been demanded by the consumer, at the rate of 8d. per unit.

"(*c*) For any further quantity exceeding the equivalent of 100 hours of supply at such maximum power, at the rate of 3d. per unit."

So as to produce a low general average price, and thus to popularise the electricity supply, *it is essential that the follow on price should be as low as possible*, and the initial price not less than 8d.

The following clause, which is the same in principle as those preceding, has the merit of directness and simplicity. Except that the service charge is correctly made upon the *actual* maximum demand of the consumer, and not upon his *possible* maximum, the method is the same as that which was advocated with such foresight by the late Dr. John Hopkinson.

"The undertakers shall be entitled to charge the consumer at the following rate per quarter :—

"(*a*) A service charge of 10s. per 100 watts of the maximum power which has been demanded by the consumer.

"(*b*) For the actual amount of energy supplied, at 3d. per unit."

The service charge in this clause represents the net cost of having the plant equipped and ready to furnish the demand of the consumer; the charge per unit covers the running expenses to supply him and the profit.

Apart from the obstructions of governing bodies, perhaps one of the greatest dangers which the electrical supply industry can encounter is that the economics of the business, the relation of the price of supply to the costs of production, should not be thoroughly understood. The Institution of Electrical Engineers has quite recently shown signs of a disposition to consider the material welfare of the industry for which it exists, and we trust it will presently awake to the importance of considering the various items of cost of production and supply with the generators, mains, and accessories to which it has now devoted so much attention.

London United Tramways.

At last, after weary months of delay, the opposition to the opening of the electric tramways in the West End has been withdrawn; on Friday last week, just in time to catch the enormous holiday traffic, the electric cars began running between Shepherd's Bush and Kew Bridge. Needless to say, they were besieged by crowds of would-be passengers, anxious to try the—to them—novel sensation of an electrical drive in the open air, and to experience the comfort and luxury of the beautiful palace cars which have superseded the old "slow-coaches."

It is stated that the Kew authorities have made arrangements to transfer their more delicate instruments to new quarters, where they are not likely to be troubled by the irresistible march of modern progress. This is as it should be; but what a pity that the step was not decided upon long ago! However, all is well that ends well; we tender our heartiest congratulations to the London United Tramways Company on the accomplishment of their aims, and with not less heartiness to the residents in the Western suburbs, who are the first to experience the advantages of electric tramway facilities in the vicinity of the metropolis.

Marconi Patents in America.—The Marconi wireless telegraph patents have recently formed the subject of a suit heard in the U.S. Circuit Court, New York. Complaint was brought by L. C. Learned against Guglielmo Marconi, and it has been dismissed by a decree just signed by Judge Coxe. According to the New York *Electrical Review* the decision seems to end the long-standing dispute over the validity of the wireless telegraph patents obtained by Marconi. The complaint was filed October 17th, 1899. The plaintiff, Mr. Learned, contended that wireless telegraph apparatus was invented by A. E. Dolbear in 1882, and that the patents came into his possession on July 22nd, 1899. He further contended that in reporting the international yacht races in 1899 Marconi had infringed some of the Dolbear patents. A considerable amount of expert testimony was taken in the case. Dr. J. A. Fleming, of London, testified that he had experimented with apparatus constructed under the specifications of the Dolbear patent, and failed to obtain results. He furthermore testified that Marconi's apparatus depended for its action upon the production of electric waves, the essential element used for this purpose being the spark gap; this is entirely absent in the Dolbear arrangement. It is believed that other patentees of wireless telegraph systems were interested with Mr. Learned in his suit, and that the outcome of the action virtually establishes the validity of Marconi's patents.

Cables in War-time.—In the columns of the *Times* during the Spanish-American war there occurred an interesting controversy concerning the position of submarine cables in war. Prof. Holland's views that a cable going from a belligerent's territory to neutral ground was only liable under international usage to be cut within the belligerent's territorial waters were regarded at the time as rather academic. They are reinforced by Article 5 of the American Naval War Code, which lays down that :—

The following rules are to be followed with regard to submarine telegraphic cables in time of war, irrespective of their ownership :—

(*a*) Submarine telegraphic cables between points in the territory of an enemy, or between the territory of the United States and that of an enemy, are subject to such treatment as the necessities of war may require.

(*b*) Submarine telegraphic cables between the territory of an enemy and neutral territory may be interrupted within the territorial jurisdiction of the enemy.

(*c*) Submarine telegraphic cables between two neutral territories shall be held inviolable and free from interruption.

There is a point of controversy as to what is contraband of war. The Naval War Code divides contraband of war into what is absolutely contraband and what is conditionally contraband. The first class includes the general kinds of war equipment, all set forth at length; but as these are generally recognised as contraband there is no use in repeating the list. The "conditionally contraband" includes :—(*a*) Coal, when destined for a naval station, a port of call, or a ship or ships of the enemy; (*b*) Materials for the construction of railways or telegraphs; (*c*) Money, when such materials or money are destined for the enemy's forces; (*d*) Provisions when actually destined for the enemy's military or naval forces.

Electric Power in the Government Printing Office.—In a discussion at a recent meeting of the Franklin Institute, on the subject of electrical distribution of power in workshops, Mr. W. H. Tapley stated, says the *Electrical World*, that the Government Printing Office at Washington has now a motor equipment of 854 H.P. distributed among 200 motors. Of these 145 motors are geared to presses, aggregating a horse-power of 375. For lighting there are the equivalent of 5,000 16-C.P. lamps, and an average of 70 amperes of current is used in heating 10 press heads. Although the power used in 1899 was more than double that used in 1894, and the boilers were called upon to heat 1,000,000 cubic ft. more of space, the total cost of coal and gas for 1899 was only $5,614.75, as against $27,812.13 in 1894.

ELECTRICAL EQUIPMENT OF THE NEW PHYSICAL LABORATORIES, OWENS COLLEGE.

By W. P. STEINTHAL, M.Sc.

The authorities of the Owens College have been enabled, through the munificence of various donors, to build and equip a new laboratory for the study of electrical engineering and physical science, which is probably the finest of its kind in this country. The laboratory will compare favourably with any of the great electro-technical institutes of the Continent, such as Darmstadt, Hanover, Charlottenburg, Carlsruhe, and Zurich, and is a very great advance on any laboratory that has yet been erected in England.

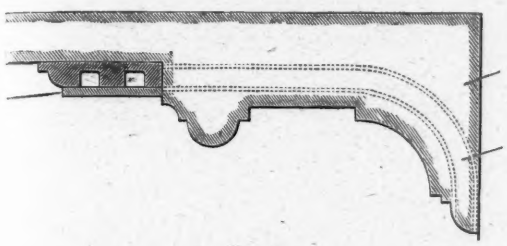


Fig. 1.

The architect, who designed the building to the instructions of Prof. Arthur Schuster, F.R.S., is Mr. J. W. Beaumont, of Manchester. The foundation stone was laid on October 4th, 1898, by the late Mr. Henry Simon, M.Inst.C.E., and the laboratory was formally opened by Lord Rayleigh, in the presence of a distinguished gathering of scientific men, on June 29th, 1900.

It is not the intention of this article to go into the details of general design or equipment or the description of apparatus, but simply to describe the electrical arrangements for lighting, power, and experimental work.

The authorities will, in all probability, publish a complete account of this institution, in pamphlet form, at a later date.

Electric Lighting.—The electric lighting of the building was designed with three main objects in view :—

1. Economy and efficiency in working.
2. Accessibility of conductors, so as to allow of easy alterations or additions.
3. Neat appearance.

After consultation, it was decided to enclose the conductors partly in wood casings and partly in steel tubes. The cornices were so designed that the final moulding, dying into the ceiling, was at the same time a casing for electric light conductors. (See fig. 1.) Whilst the cornice was being plastered, steel bends were inserted to allow of wires being drawn through the cornice without disturbing the plaster, for running down to switches, brackets, fuseboards, sockets, and so forth. There is, therefore, a continuous casing round each room, and the further casing required on

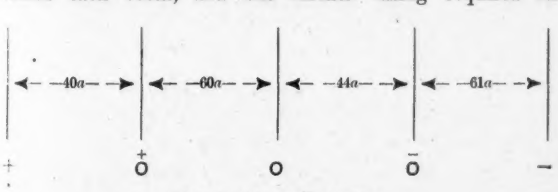


Fig. 2.—Load Diagram.

the ceilings has been designed and erected to represent a plaster mould panelling the ceilings. The walls being all glazed brick, switch wires, &c., have been brought down the walls in steel conduits. The results obtained are very satisfactory, and though perhaps rather costly, the neat appearance and general accessibility amply compensate for the extra cost involved.

Current for lighting is obtained from the mains of the Manchester Corporation at 100 volts. The Corporation has brought five wires into the building, and the installation is balanced, as evenly as could be arranged, between the centre and the inner positive and negative, and between the latter and the outer negative and positive. The load, when all lights are turned on, is shown by the diagram, fig. 2. The five Corporation wires are connected to a switchboard, consisting of four 50-ampere D.P. change-over

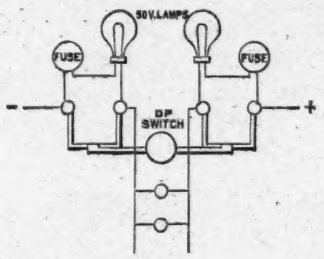


Fig. 3.

switches and fuses to enable the laboratory dynamos to be connected to the lighting installation for demonstration purposes. From this board cables are taken to various submain boards, which are again connected to branch fuseboards controlling the various lights.

Fig. 4.—Lecture Room.

Incidentally a device in connection with the main switchboard should be mentioned ; an arrangement to enable the steward, when turning off the main switches before leaving at night, to detect whether any lights have been left on. Across each pole of the four main switches is placed a 50-

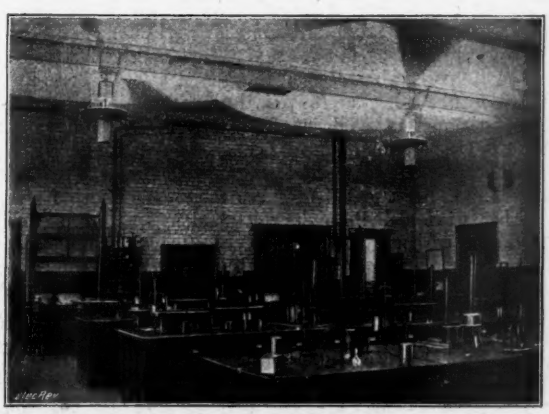


Fig. 5.—Elementary Laboratory.

volt lamp. When the switches are in, these lamps are short-circuited. If, on any circuit, one or more lamps have been left on, in turning off the main switches the lamps so left are thrown into series with the detective lamps, which con-

sequently glow dull red. This arrangement is shown diagrammatically in fig. 3. The device was taken from Dr. Wiedemann's laboratory at Erlangen.

The large lecture room and the elementary laboratory are lighted by means of inverted arc lamps. The arc lamps have the mechanism above the arc, this type of lamp being much neater in appearance than the lamps which have the mechanism below the arc.

The dynamo house and the electro-chemical laboratory are lighted with ordinary open type arc lamps. In the centre of the large lecture room is a platform for the projector lantern, and the arc lamps, which light the room, are controlled by two-way switches, so that they can be turned on or off either from this platform or from the lecture table. One

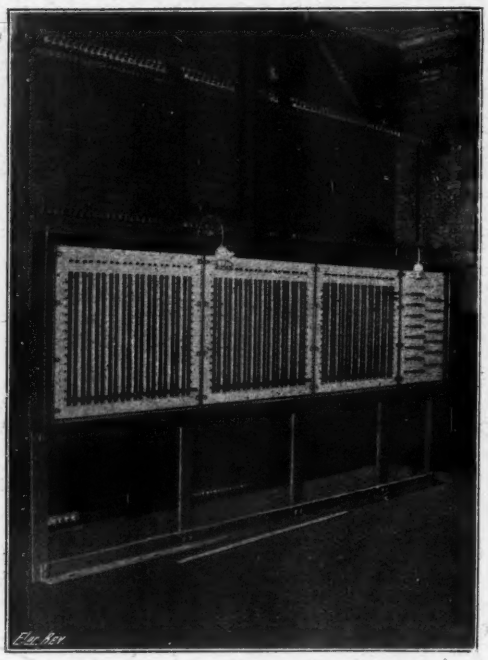


Fig. 6.—Main Distributing Switchboard.

enclosed arc lights the entrance hall, and the remaining portions of the building are lighted by means of incandescent lamps.

Fig. 4 is a photograph of the lecture room, and fig. 5 is a photograph of the elementary laboratory, both taken by artificial light; the absence of heavy shadows should be noticed.

Electric Motors.—Electric motors are used for driving:—(1) the hoist; (2) freezing apparatus in the Kryogenic laboratory; (3) dynamos in the engine house (alternatively with a gas engine); (4) lathes in the workshop. The first three are supplied at 400 volts, and the fourth at 200 volts.

The 400-volt cables are run in screwed smooth bore iron tube, the tube being carefully earthed, as are also the magnets of the motors. The supply is arranged as follows:—The two Corporation outers are connected to two Thomson-Houston magnetic blow-out fuses of that company's latest pattern. These two cut-outs are mounted on one frame, together with a D.P. high voltage, knife-pattern switch, fitted with carbon-break contacts. From this switch cables are run to a board, on which are mounted three D.P. fuses, to carry 50, 20 and 15 amperes respectively; and from these fuses circuits, all in screwed iron piping, are run to the dynamo house, hoist and freezing apparatus. The motors were manufactured by the Westinghouse Company, the Otis Elevator Company, and Crompton & Co. respectively.

Telephones.—The Professor's ante-room, the dynamo house, and the lecture preparation room are connected by means of intercommunication telephones.

Clocks.—The clocks throughout the building are controlled by a synchronising clock in the basement, the wires between the various clocks being run in steel tubes.

Experimental Circuits.—Lastly, we come to the wiring for the experimental work. The various experiments conducted by students in a laboratory of this description necessitate a variety of voltages ranging from 2 to 100. The maximum current required is about 50 amperes, except for the electric furnaces, which are provided with a special circuit running direct to the dynamo house.

It was necessary to arrange for current to be taken either from the cells or the dynamos. For the purpose of obtaining various voltages the cells are arranged in various groups of one, two, five or 10 cells. The cells and dynamos are connected to distributing switchboards, which will be described later.

Before actually describing this experimental wiring, it may be well to explain that a great deal of care and thought was given to the method of running the wires. The

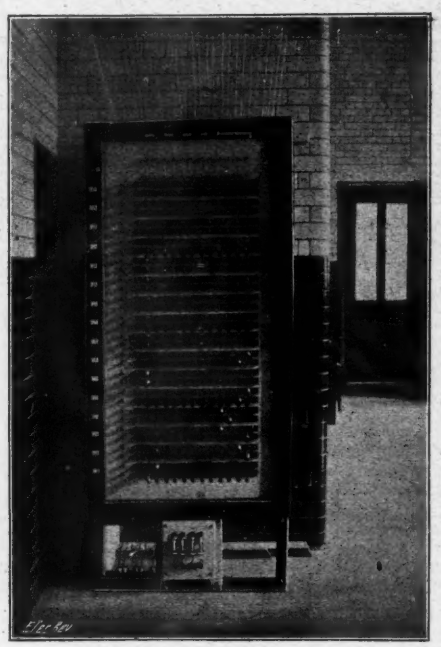


Fig. 8.—Small Plug Board.

points to be kept in view were chiefly economy in erection, durability, ease of manipulation, accessibility for alterations or additions, and so forth. To save expense it was at once arranged that the conductors, except in one or two special cases, should be run in bare wire. To arrive at a satisfactory current density to be used for the bare conductors, to allow of reduction of weight to a minimum and still not to risk any undue heating, a series of experiments were made, and the following formula was finally decided upon to give the sizes of wire to be used for various currents which would be required in different rooms:—

$$c^2 = 15\ d^3$$

where c = current in amperes; d = diameter of wire in millimetres. The nearest standard gauges to the diameters thus deduced were finally adopted. The formula applies to copper

Fig. 7.

conductors; in the case of aluminium being substituted for copper the constant would require altering.

Proportionally a slightly thinner wire could be used with aluminium, as, the outside surface being larger, any heat generated is conducted to the air at a rather more rapid rate.

Owing to the high price of copper, the alternative of using aluminium throughout has been discussed. On making calculations as to the relative costs it was found that, with aluminium at £164 per ton, this metal would be slightly cheaper, though owing to the comparatively small

quantity by weight to be used in this instance the saving would not be great. Aluminium has the advantage that it does not corrode in the atmosphere, is light and easy to handle, and has a very neat appearance. Further, there is no difficulty in making electrically and mechanically sound joints with an ordinary blow-pipe. A little practice is required, but any intelligent workman will acquire the necessary experience in a very short time.

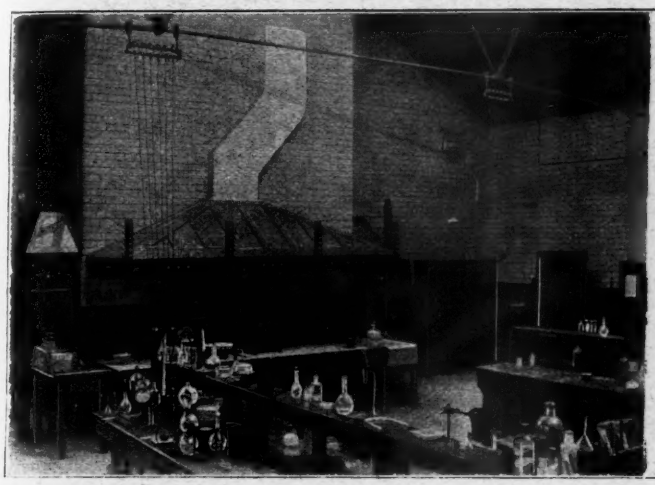


Fig. 9.—Electro-chemical Laboratory.

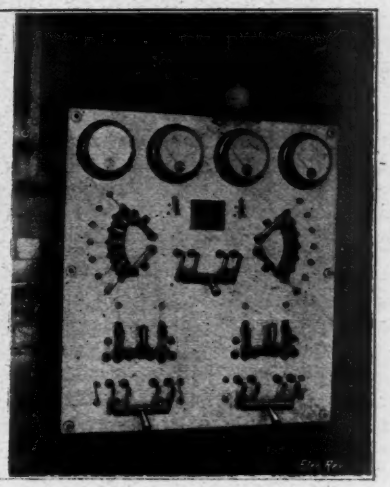


Fig. 10.—Battery Charging Switchboard.

Quickness in manipulation is the chief factor, as in small wires aluminium softens very near its melting point.

Prof. Schuster decided that one floor should be wired with aluminium. The only doubtful point, which experience will have to decide, is whether there will be any electrolytic action at the places where the aluminium wire is terminated at brass set screws, aluminium being strongly electro-positive to copper. As, however, there are no heavy currents traversing these wires, it is improbable that any trouble will arise.

In describing the system we shall start from the main distributing switchboard (fig. 6). This board consists of a series of horizontal and vertical bars, drilled in such a manner as to enable the attendant, by means of plugs, to make an electrical connection between any horizontal and vertical bar as desired. The bars, of brass, are fitted on to marble slabs, the front bars being machined and polished, the bars at the back left rough. The latter are the horizontal set. There are 60 vertical bars and 15 horizontal; the latter are connected through switches and fuses (seen on the extreme right of the board) to the dynamos and cells, and the former are connected through fuses to circuits running to different rooms of the laboratory, each circuit ending in a pair of terminals with set screws to enable wires and cables to be attached. Some of these circuits have various tappings at different points, so that one circuit can be used in several places at once. To avoid confusion, each circuit at the switchboard end has a label marked with its own distinguishing number in large type, and the numbers of the rooms into which it runs, in smaller type. Also each pair of terminals at the other end has a label with the number of the circuit.

Incidentally, it may here be stated that a very neat system of numbering the rooms has been adopted. If a room on the ground floor is, say No. 5, the corresponding room above on the first floor is No. 15, the room above that, on the second floor, is No. 25, and so on.

The 13 top horizontal bars are connected to Nos. 5, 6, 8, 10, 15, 20, 30 of No. 1 battery, which consists of "Tudor" cells, and Nos. 0, 5, 10, 15, 20, 30 of No. 2 battery, which consists of "Chloride" cells. The last two are connected to the dynamos. By this means practically any voltage between 2 and 100 can be obtained in any room. The plugs are double spring type, specially designed for this board, there being a spring connection at both ends, thus ensuring a good and reliable electrical contact at both holes (fig. 7). A certain number of circuits from this main board go to feed a smaller plug board, from which again 16 circuits are taken. This board (fig. 8) has 12 vertical bars (8 connected to the large plug board through fuses, and four connected direct to the accumulators through switches and fuses), and 32 hori-

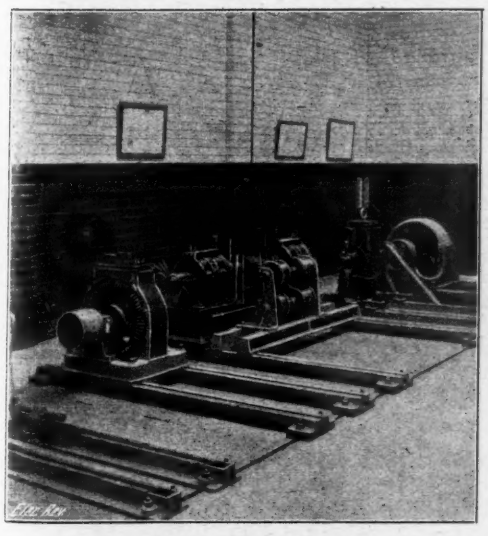


Fig. 11.—Dynamo Room.

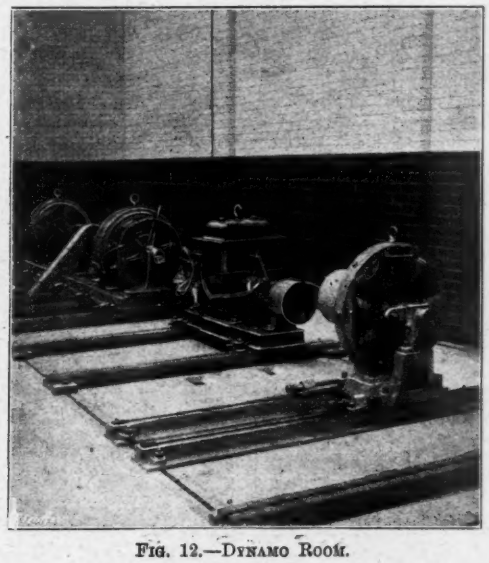


Fig. 12.—Dynamo Room.

zontal bars, from which are run the 16 circuits referred to above. The plugs on this board are of a somewhat different design, and are, in the writer's opinion, inferior to the double spring plugs of the larger board. These plugs make contact at the front in a conical seat, and have a spring action for the back connection. Owing to the difficulty of boring all the conical holes exactly the same, a plug may fit better into one hole than into the neighbouring one. With the double spring plug this is entirely avoided, as the plug is self-adjusting, and does not depend upon the exactness with which the holes have been bored.

The experimental circuits in the electro-chemical laboratory require some special description.

This room (fig. 9) is a large one, 36 ft. by 37 ft., with a gabled roof supported by iron tie-rods and struts, and is very light and airy. It is furnished with one large fume flue and other small ones, and working benches for upwards of 30 students. Each student has a set of six terminals at his disposal, each terminal being protected with a fuse. Eight of these sets are formed by tappings from circuits Nos. 25, 26, 27 from the large plug-board, which are run side by side round the walls of the laboratory; the remainder of the terminals, 23 sets in all, are taken from the Chloride cells, Nos. 40 to 45, the supply wires being run direct from the cells to a fuseboard in the laboratory, and there divided into three sets of circuits, one of which supplies seven positions round the walls, and each of the other two supplies eight positions on the two long benches running the length of the room. In one corner of the room two heavy vulcanised cables (61/12s) are brought direct from the dynamo house to a terminal board, enabling currents up to 700 amperes to be employed for electric furnace work. With this furnace temperatures of 3,500° C. and upwards can be reached, and interesting researches on spectra of metals and other physical and chemical problems are to be looked for. The furnace itself consists of blocks of highly refractory limestone obtained from quarries near Bath, bound round with sheet-iron, and having a space hollowed out to receive a crucible, made of compressed carbon; the poles of the furnace are composed of large carbon rods passing through grooves in the blocks, the cables being attached to them by heavy metal clips supported on slides to enable their distance apart to be regulated. An experiment usually takes some 8 to 10 minutes to perform.

In the photometer room, which is situated in the basement, wall-plugs are arranged on 100-volt and 200-volt circuits for testing incandescent lamps.

Charging Switchboard.—Owing to the uneven use of the various cells, it was necessary to arrange a switchboard to enable any group of five cells to be charged independently, and for convenience the board was designed to enable any group to be charged by either of two dynamos, or any number of successive groups, or any group from one battery in parallel with any group in the other. Fig. 10 is a photograph of this board. Figs. 11 and 12 show the equipment of the dynamo room. This shortly describes the various electrical arrangements which my firm has carried out.

In conclusion, I should like to take this opportunity of expressing my admiration for the marvellous manner in which Prof. Schuster worked out the very complicated details, more especially of the experimental wiring. The immense amount of time and thought which the Professor gave to this section of the work alone, can only be appreciated by those who have had the pleasure of working to his instructions.

AMERICAN COMPETITION AND BRITISH MANUFACTURERS.

[COMMUNICATED.]

The perusal of the articles which have lately appeared in the daily papers, and in *Cassier's Magazine* recently, has induced the writer to submit his ideas and experience to the consideration of those most interested in the present condition of the engineering trades, and the competition in the iron and steel industries owing to the recently formed combinations in the latter in the United States of America.

In the nine articles on American competition in *Cassier's Magazine*, only certain points agree with the personal experience of the writer. The opinions expressed in the articles are "from American points of view," while the writer can only claim to have European experience. However, the opinions herein expressed may be worthy of consideration. The articles have aroused considerable interest in the minds of both employers and employed, and a disinterested review can only lead, with fair consideration, to deeper thought and endeavours to improve matters by fairly facing the present conditions of European manufacture.

Let us look first at the "superior manufacturing methods" referred to by the editor of *Cassier's*. Attention, no doubt, at this point is specially directed to the manufacture of iron and steel.

It will doubtless be conceded that Great Britain had worked those industries up to the highest point of perfection by the time that Americans found that it was possible for them to produce the necessary materials for themselves, and it is well within the writer's memory that American gentlemen, desirous of advancing the manufacture of iron and steel in their own country, came over to visit English iron and steel works, and by exchanging drawings of cranes, &c., obtained information in regard to blast furnaces and Bessemer plant of considerably greater value.

The works they visited had been built up gradually, and were naturally hampered by having to improve and enlarge existing plant, while our present competitors, after studying the latest European practice, placed the design and construction of their plant in the hands of engineers who were not cramped by old arrangements of buildings and plant, but had a free hand in including all the latest improvements as well as in attempting to bring about larger output at less labour cost.

Under these conditions they were able to put down blast furnace plants of higher capacity and efficiency at a time when a home demand, assisted by a protective tariff, ensured a profitable output.

In many cases the designers and managers of these highly productive iron and steel works are Englishmen, who, if engaged in this country, would have been hampered by conservative directors and existing plants entirely unsuitable for adaptation to improved outputs, while in the United States they have been treated as experts and allowed a free hand on unbroken ground.

In this country, any advanced attempt to improve the output and efficiency of manufacturing plant is resisted by proprietors and directors who are afraid to trust their staff to develop their ideas, and who require them to endeavour to utilise existing plant.

Then, again, in regard to finding a market for the products of these new works, while British works are tied down by almost impossible specifications as to the materials produced, the American manufacturers have had more freedom in this respect, enabling them to produce a suitable class of material that could command a ready sale; the manufacturers in fact were to a certain extent able to bring into the market large quantities of material of a fair quality which was suitable for most uses, thus establishing a more or less standard range that could be manufactured in bulk at reasonable cost, free from the restrictions to which British works are subjected.

The editor of *Cassier's* mentions "native American enterprise," and this, no doubt, seems to be a very important point; but it may be more apparent than real when analysed.

The very fact that American coal, iron and steel have been brought to British markets lately tends to show that very remunerative prices are not readily obtainable in other countries, and that the supply is considerably in excess of the demand in their home markets. Surely, Britain should be the last place in the world in which to obtain good prices for the products of American iron and steel works. With a strong inquiry and unlimited output at one's disposal, any man can be enterprising, but British manufacturers have passed through these experiences, and it may be that in the near future our friends may find it not the most profitable result of excessive production to have to come with their

goods to this country on the basis of a Spring or Autumn sale, just at "turnover" prices.

Regarding the editor of *Cassier's* remark of "better products," this will not readily be acknowledged by British manufacturers; *cheaper* maybe, but better? Take, for instance, the locomotives not long since obtained by British railways from America; they have not "knocked" British workmanship much, especially if the opinion of those most intimately connected with them is taken as a criterion, *i.e.*, the drivers. Without dwelling too long on this point, there is no doubt that if the record of these locomotives had been good we should have had ample evidence of the fact from American "enterprise."

The American system of classifying pig iron is probably superior to the British, and will doubtless soon be standard, but at the same time we are not at all inclined to accept the suggestion that consignments of British pig iron are inferior to American produce.

Again, in the matter of steel, a lower cost of production may be in many cases found to exist, but when the question of quality comes into play, and the complying with strict specifications, then it will be found that the "better product" is still to be found in the Old Country.

At a works established in England a few years ago American machinery was largely installed, possibly on account of quick delivery, in place of English machinery, but when the machines had been run a little more than a year they required overhauling, which would not have been the case with machines of British manufacture. The writer had an opportunity of inspecting the machines, which were of the wood-working class; until this time he had been impressed with what he had heard of machines of American manufacture, and he was greatly surprised to see the way the pulleys rocked about on the shafts after such a short time of use.

However, the writer has nothing but praise for the American machines he has had an opportunity of examining, in regard to their *design* for producing special work, and their output capabilities. No doubt, except in special cases, most English machines are designed to deal with a large range of work rather than for turning out large outputs of certain shapes or classes of work.

The claim of "better workmen" opens up many points for consideration.

If, as the writer has been led to suppose, the system is general in the United States, of allowing the first man applying, in the case of a vacancy, to fill the post, without reference or agreement, and of retaining him if satisfactory, or dismissing him without notice if otherwise, and filling his place in a similar manner until a satisfactory man is found, the system must, while it can be maintained, result in the "survival of the fittest," and has many advantages.

Such conditions are strange to Englishmen, and could hardly be established here, and it is scarcely likely that as American workmen get settled down in various localities, with wives and families, they will continue to put up with such treatment; the advent of trades unionism will probably in the near future have something to do in the matter of bringing the conditions of engaging and dismissing workmen more into line with British practice.

The great benefit of the system above mentioned is to make a man apply himself to his work, in order to become proficient and prove to his employers his value and capabilities; also it has the effect of greatly relieving the foremen.

Comparing this with the case of a large engineering shop in an English works, where the general principle of the workmen was to do as little as possible when the foreman was not in close proximity, and where, as was frequently the case, the foreman came into the works about 6.30 or 7.0 a.m., and was not seen again until after 9.0 a.m., it will readily be seen that the best output was not obtained from the running machines. There is little doubt that the amount of work turned out during the early hours from 6.0 a.m. to 8.30 a.m. is very much below what it should be, taking into account the running of the machinery.

An attempt to reduce this loss to a minimum by doing away with the breakfast half-hour, starting the shops at 7.0 a.m., and working straight on to noon, did not realise the desired result, because the men turned up without breakfast, and complained of being hungry and not capable of applying any great exertion till after dinner.

It would appear that the only way to get the British workman to do an honest day's work, without having a foreman for each man, would be to adopt a more general system of piecework, or a bonus on the output, or else to give him an interest in some tangible form, so that loss of time and output would affect his pay.

Until the workman realises that his pay is a fair return for his work, and that it is to his advantage to turn out as much manufactured product as he well can in the time, and until he is not always under the impression that he is very much underpaid, so long will this country be subject to successful competition from other nations.

While on this subject the writer would like to record his opinion, based on considerable experience, that the tendency of the struggle for shorter hours for workmen is wrong in principle and effect.

At a works lately visited, the closing hour was 4.30 p.m. Now, what is the average workman to do from 4.30 p.m. to, say, 10.0 p.m.? If there was any evidence that he applied some of this time to technical education, or even agricultural pursuits, such as gardening, &c., or household carpentry, not to mention self-culture, then there would be some satisfaction, but how far is this the case?

A demoralising condition tending to cause the British workman to have a poor opinion of his superiors is the fact that when orders for, say, steel rails or plates, are placed upon the market in general competition, the competing firms offer prices which may secure the order before going into details as to whether the conditions stated in the specification can be complied with.

The result is that the firm receiving the order finds some difficulty, in many cases, in avoiding a considerable loss through rejections. Very often the specification contains conditions of tests, which not any quality of steel can be made to comply with. For example, in the case of rails (1) a certain drop test has to be complied with; (2) a certain bending test, under hydraulic pressure, is stipulated; (3) also certain limits are fixed for the chemical constituents.

In many cases it is found that these conditions cannot all be satisfied by tests applied to the same piece of rail. It is well known to analytical chemists that steel, as manufactured into rails, is not homogeneous, and by careful selection, various proportions of deleterious constituents can be found in drillings taken from different rails from the same cast, and even from the same rail. To comply with the inspector's requirements necessitates a considerable amount of *dodging*.

In the case of plates a limit variation of only 2 tons in some cases and 4 tons in others is allowed in the tensile test applied to test pieces; it is common knowledge that in the instance of a large plate rolled from a single ingot, it is a comparatively easy matter to select test pieces from this one plate which will give even greater variations than are *allowed by the specification* from the same plate.

In this case also the steel is not homogeneous, and while in certain places, corresponding to, say, the outer portions of the ingot, drillings may show an analysis complying with the specified limits of sulphur, phosphorus, manganese, and carbon, drillings taken from parts corresponding with the heart of the ingot would result in the material being rejected as being of unsuitable quality. The knowledge of the manner in which test pieces have to be manipulated to pass the inspector does not tend to make the workman hold a very high opinion of his superiors.

Every now and then at some steel works an inspector *detects* some *dodging*, with the result that an exposure is necessary. A workman, or in some cases a responsible person, is dismissed; in a mild case it may be from one department to another when the man in question is well up to his business of passing material through, while if the exposure is too prominent the offending workman may be dismissed the works in disgrace—finding through influence, a similar berth at some other works. There would be a considerable stir in the rail and plate trade if the whole of the tests were carried out at an independent testing office, and prices would be greatly affected.

It would soon be found that specifications would be more reasonable, and manufacturers would be trusted to give a good suitable quality of material without being compelled to carry out impossible tests at their own costs.

Take the case of boiler plates, for which the specification gives a limiting range of 4 tons only between the highest and lowest tensile test.

A large plate of this class of steel was rolled from an ingot, and several test specimens were taken from different parts. In the testing machine these gave results, varying 4½ tons between the highest and lowest, so if the inspector had happened to have selected test pieces giving either of the two extremes, he would have had to reject the plates, while the average of the several tests proved the steel to be of the quality specified.

Steel manufacturers would be subject to very considerable loss if they were not able to prevent steel of suitable quality being rejected by manipulating the test pieces examined by the inspector.

THE MAINTENANCE OF CENTRAL STATION BATTERIES.

By A. J. ABRAHAM, A.M.I E.E., Assistant, Wigan Corporation Electricity Works.

There is no doubt that, with the exception of those electricity works where the battery is large enough to warrant the employment of a skilled attendant, the central station battery is much neglected. This is due to the fact that the duty of keeping it in good condition generally falls to the lot of the engineers-in-charge, who, in the majority of cases, are either ignorant of the proper treatment of accumulators, or unwilling to undertake what they consider to be troublesome or unpleasant duties. In this way the battery receives scant attention, and as no one is held personally responsible, each shift engineer has a knack of jotting down the faulty cells on the log sheet, in the hope that one of his fellow workers will attend to them. One has only to visit two or three direct-current central stations, which have been working some time, to be struck with the fact that everything but the battery is kept in a more or less efficient condition. A few, and by no means uncommon, instances, will show to what usage accumulators are often subjected.

(*a*) This case, the worst I have ever come across, and one which, perhaps, many will disbelieve on account of its being almost too bad to be true, was that of a Tudor battery which had been put into a station in the Midlands. After it had been working for a short time one or two cells became sulphated. The engineer-in-charge, evidently in ignorance himself as to what ought to be done, consulted the chief engineer, who ordered that these faulty cells be cut out of the battery by clamping ·2 in. cable across them. He then wrote the Tudor Company to send a representative to put the cells right. History does not relate what the representative said when he saw what had been done "to keep the cells from getting worse."

(*b*) In a certain central station in the North of England, the works superintendent (who was a mechanical engineer, by the way) was held responsible for the maintenance of the E.P.S. set of accumulators therein. There was no ampere-hour meter in circuit with this battery, so the works superintendent ordered that "the kilowatts taken out of the battery during the discharge should be put in again." I have the written order by me now.

(*c*) A battery in a station in the South had every plate renewed before it had been working 18 months, for the following reason: The rate of charge was 100 amperes, with a maximum of 150. Every day throughout one summer this battery was completely discharged, and then charged again at the rate of 260 amperes, the reason assigned being that "if they only charged at 100 or 150 amperes, it was impossible to fully charge the battery before the heavy load came on."

(*d*) Another battery had been neglected so much that many cells had become sulphated, and would not gas with the remainder of the battery. To bring these right, the battery, after every discharge, was charged at the proper rate, but had an overcharge of from 100 to 200 per cent. daily. Soon, on account of these excessive overcharges, trees began to form across the plates, eventually short-circuiting the cells, and making them worse than before.

The above instances speak for themselves, and give one an idea of how accumulators are managed in most electricity works. They are by no means isolated cases, and, were it necessary, I could give many other examples equally as bad.

It is of little use trying to keep accumulators in order without a milker, for should a cell become quite run down from any cause, and it be not possible to milk it up during the discharge of those cells in series with it, then, of course, during this discharge it will be charging the wrong way and will eventually reverse its polarity.

If a cell is badly shorted between the plates for any length of time, the positive plates on each side of the short will probable buckle outwards owing to the heavy discharge, just as they will buckle throughout a whole battery in the case of a short circuit, or a too heavy discharge. A plate which has buckled badly should be cut out of the cell and straightened on a smooth wooden surface with a mallet; if it is split, then, of course, a new plate is needed. Forcing wood, &c., between buckled and touching plates is not much good; much better take the buckled plates right out of the cell, even though they cannot be burnt in again for some time.

If the plates in a bad cell have turned a rusty colour, it is best to empty the cell and put fresh acid in before milking up, as plates in this condition point to iron in the acid.

When a battery is charging or discharging, and it is desirable to cut a cell out without interfering with the charge or discharge, as the case may be, unless the cell is quite dead never short circuit it, as is sometimes done, but put a water resistance in parallel with it until all the plates of one pole are cut out, then a cable may be clamped across and the resistance removed. The same rule must be observed in putting the cell back again if the circuit is not to be broken in so doing.

As in everything else, it is easier to keep accumulators in a healthy condition than to get them in good order after they have been allowed to become nearly dead through neglect. For this reason the voltage of each cell should be taken at least three times a week, namely, once at the end of the heaviest discharge in the week, to see that no cell falls below 1·7 volts, and twice a week during the last half hour of the charge. If at the end of a charge the E.M.F. of a cell is found to have fallen even in the slighest degree behind that of the others, this cell should not be left (as it generally is), because it is "not bad," or because it is hoped that it will improve at the next charge. The glass tubes should immediately be removed and washed, a thin board cut the width of the plates should then be passed between them to remove all possible slight short circuits, and at the same time the surfaces of the negative plates should be rubbed, taking care if it is an old cell not to stir the mud up at the bottom of the case. If this is done, generally this cell will be found to equal the others at the end of the charge.

A battery which is not discharged to its full capacity should not require an overcharge of more than 40 ampere-hours plus 10 per cent. of the discharge, but every cell should be examined to see that it gasses freely before the charge is stopped. On the discharge of a battery no cell should be allowed to fall below 1·7 volts. If one is found to have dropped below this the discharge should immediately be stopped or the milker put on the faulty cell, which should then be examined as I have described and not discharged further until it has been righted. If the specific gravity is low when a cell is fully charged, acid may be added, but not otherwise. Where possible it is best to use condensed water with which to replenish the cells if this can be obtained without grease.

Every station should engage one engineer-in-charge on account of his special knowledge of and experience with accumulators, and he alone should be held responsible to the chief engineer for their condition. It is worse than useless giving the engineers-in-charge collectively the care of this portion of the plant, for reasons already stated.

INSTITUTION OF ELECTRICAL ENGINEERS.

SOME NOTES ON POLYPHASE SUB-STATION MACHINERY.

By A. C. Eborall, Member.

(Abstract of paper read on Thursday, March 14th, 1901.)

(*Continued from page* 605.)

When the machine is loaded the "V" curve alters somewhat, on account of the increased armature leakage, as indicated in fig. 5. The amount of this alteration is an indication of the quality of the armature design in this respect—the smaller the alteration in shape and the less the inclination of the axis *a b* from the vertical, the smaller the pressure drop, and the smaller the increase of excitation necessary for the motor from no load to full load in order that it may work under the best conditions.

Synchronous machines, whether motors or generators, should be so designed that the shape of their "V" curves lies between the two limits mentioned above, for then excellent parallel running, high overload capacity, and good pressure and excitation regulation will all be attained. Running as generator, the full-load drop of the machine at constant speed and excitation should be in the neighbourhood of 5—6 per cent. with 100 per cent. power factor, and 18—20 per cent. with 80 per cent. power factor. Better regulation than this is not asked for in modern practice with units of medium and large output, nor is it desirable.

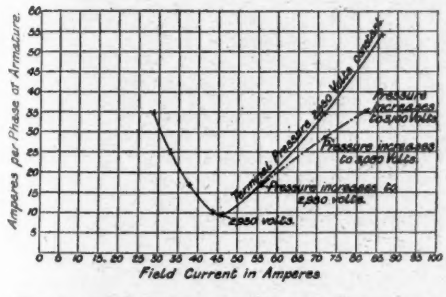

Amperes per Phase or Armature.
Field Current in Amperes
Pressure increases to 3,100 Volts.
Pressure increases to 3,050 Volts.
Pressure increases to 2,990 volts.
2950 volts.

Fig. 4.—"V" Curves for 650-b.h.p. Three-phase Synchronous Motor.
Constant Speed. No Load.

On the other hand, if the excitation is less than the critical value, then the impressed pressure must lead the current.

The dotted curve to the right of the "V" curve (fig. 4) illustrates clearly what happens in a transmission plant when the impressed pressure on the synchronous machinery is left to take care of itself; the pressure at the ends of the feeders rises steadily with increased excitation of the synchronous machines. In this case the 1,000-kw. generator supplying current to the motor (through a long three-core cable) had its excitation adjusted once for all at the beginning of the second test, to such a value that the impressed E.M.F. on the motor was 2,950 volts, *when the armature current had its minimum value*. The excitation of the synchronous motor was then increased, the dotted curve showing the increase of (leading) armature current; the effect of this was to raise the impressed pressure on the motor from 2,950 volts to 3,100 volts. That is to say, the drop in the feeder (which possessed a considerable inductive drop, owing to the presence of a choking coil in series at the station end) was first wiped out, and then the pressure at the sub-station end was gradually increased to the extent of over 5 per cent. simply by increasing the excitation of the motor. The frequency was constant throughout the tests, and consequently the motor speed also.

A little consideration of the above described characteristic of synchronous motors will show at once the great superiority of synchronous motor-generators and rotary converters over an

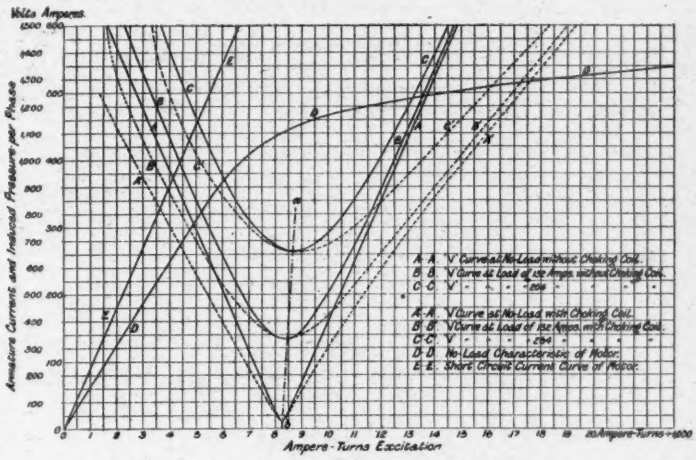
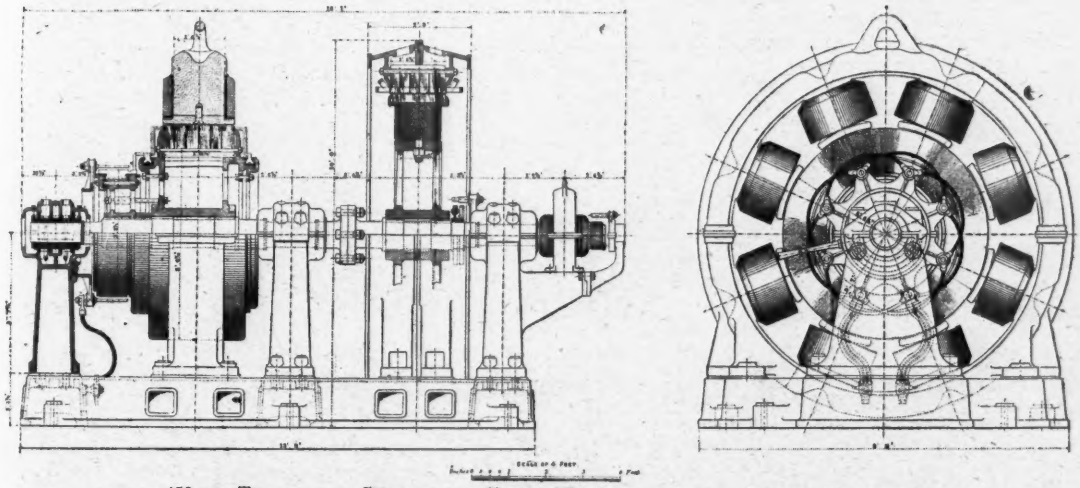

Volts Amperes.
Armature Current and Induced Pressure per Phase
Ampere-Turns Excitation
A A Curves at No Load without Choking Coil.
B B Curves at Load of 125 Amps. without Choking Coil.
C C
A A Curves at No Load with Choking Coil.
B B Curves at Load of 125 Amps. with Choking Coil.
C C
D D No Load Characteristic of Motor.
E E Short Circuit Current Curve of Motor.

Fig. 5.—"V" Curves for 725-b.h.p. Two-Phase Synchronous Motor at Constant Pressure.
Constant speed. Three different loads.



450-kw. Three-phase Synchronous Kolben Motor-generator. (Prague Tramways.)
Speed, 240 revolutions per minute. Frequency, 48 cycles per second. Pressure, 3,000/600-650 volts.

Returning to the actual no load "V" curve shown in fig. 4, it will be seen that when running practically without load, at the constant impressed pressure of 2,950 volts per phase, the excitation for the minimum armature current of 9·5 amperes is 46 amperes; a reference to the no-load characteristic of the machine (fig. 6) shows that with this minimum value of armature current an induced pressure of 2,250 volts per phase is attained. The difference between the two pressures under these circumstances is due to the impedance of the armature and to the pressure and current beats which occur with all synchronous machinery. At constant impressed pressure a decrease or increase of excitation causes a fairly rapid increase of the armature current (and apparent watts) taken by the motor. If the excitation be increased above the value corresponding to maximum power factor, the impressed pressure at the terminals of the motors must of necessity lag behind the current.

asynchronous machine for sub-station purposes, from the point of view of the regulation of the system, and the line losses, &c. Instead of having a lagging idle current throughout the system, wasting energy and impairing the regulation at all points, the power factor of the system can be kept practically at or about unity throughout.

It is not possible to get a power factor of *exactly* unity in the circuit, owing mostly to the difference in the E.M.F. waves of line pressure and motor pressure. Large synchronous motors, if of good design, generally have full load power factors of 96 to 98 per cent. when working at the excitation corresponding to minimum armature current.

In practice with rotary converter sub-stations, if the machines are compounded, the power factor of the system will be nearly unity at about half load, the current lagging somewhat before this and lead-

ing afterwards. If the rotaries are shunt-wound, or if synchronous motors are employed, the field current is so adjusted that the power factor is highest at about three-quarter load. If heavy overloads are expected, the machines had best be somewhat over excited at full load in order to increase the impressed pressure, especially if synchronous motors, for the overload capacity is thereby increased, the torque being proportional to the square of the impressed pressure. Thus, with a synchronous motor-generator sub-station, if the motors are well designed, it is not necessary to alter the excitation continually with the load. Two adjustments between no load and full load will be generally advisable. The small amount of field regulation required in practice with well-designed synchronous motors is well illustrated by fig. 5.

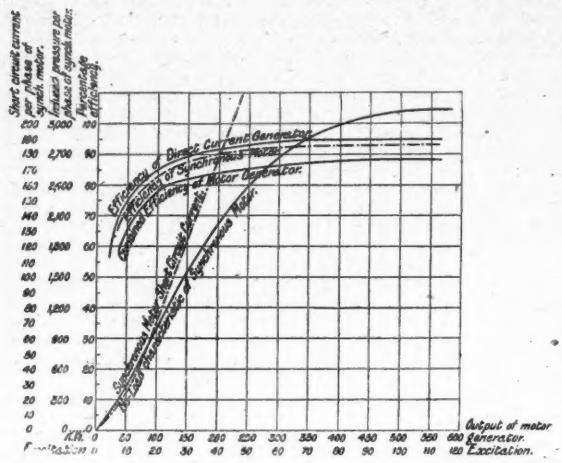

Short circuit current per phase of synch. motor.
Intake pressure per phase of synch. motor.
Percentage efficiency.
Efficiency of Direct Current Generator.
Efficiency of Synchronous Motor.
Overall Efficiency of Motor Generator.
Synchronous Motor Short Circuit Current.
Intake Pressure of Synchronous Motor.
Output of motor generator.
Excitation.

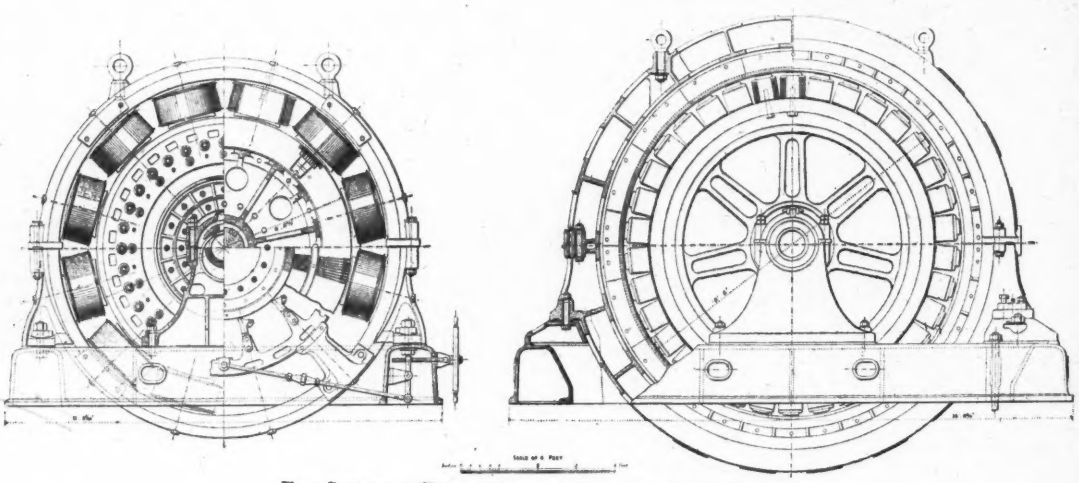
Fig. 6.—Results of Tests on 450-kw. Synchronous Motor-Generator.

If a sub-station equipped with synchronous machinery has to work in parallel with large inductive loads, such as large induction motors, or another station arranged with asynchronous motor-generators, it is as well to arrange for the lagging current to be balanced by the synchronous machines.

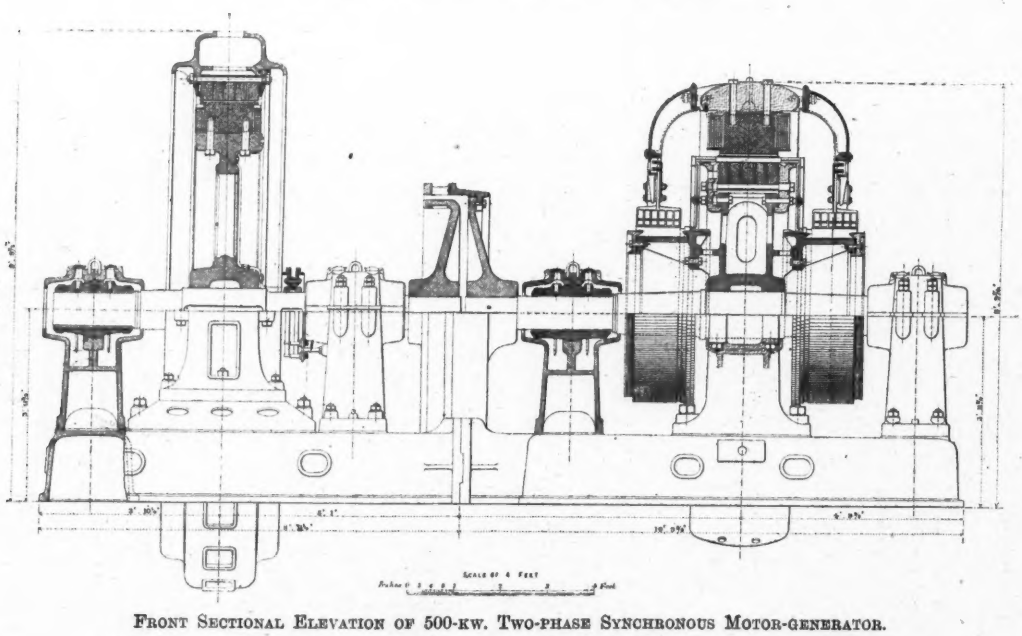
With motor-generator sub-stations the permanent overload capacity depends only on the direct current machines; it will be in general about 20 per cent. for two hours. With rotary converters the corresponding overload capacity is greater, and in practice is determined as a rule by the commutator heating. The commutators of rotary converters invariably have peripheral speeds bordering upon the upper limit of good practice—say 3,000 ft. per minute—consequently an overload of about 30—40 per cent. for two hours is as much as can be furnished without over-heating the commutators. If it were not for this, and provided the field system was well over-excited, the overload capacity could be safely taken to be 50—60 per cent. for the time stated; it would be determined by the permissible safe temperature rise of the armature coils and step-down transformers. It is assumed that the latter are artificially cooled, the normal temperature rise being 35° C. in good modern practice.

What has been called the "permanent overload capacity" above is, however, really of minor importance in practice. The important point, particularly with sub-stations feeding tramway or railway systems, is the momentary overload capacity, that is to say, the effect of short-circuits of brief duration has to be considered.

Regarding this point, the three classes of equipment are perfectly satisfactory, and there is but little to choose between them. They



End Sectional Elevations of 500-kw. Motor-Generator.



Front Sectional Elevation of 500-kw. Two-phase Synchronous Motor-Generator.
Manchester Square Sub-station, London. Constructed by Electricité et Hydraulique, Limited.

will all stand overloads of 100 per cent. for a few seconds without falling out of step. This is about the safe limit of overload capacity for standard machinery. It does not follow that the machines will drop out of step, although asynchronous motor-generators designed for high efficiency would probably pull up; the synchronous motors or rotaries would generally become unstable in their running, and start hunting.

(To be continued.)

SOME NOTES ON THE ELECTRICAL TRANSMISSION OF POWER IN COAL MINES.

By H. Ravenshaw.

(Paper read March 28th, 1901.)

The object of this paper is to discuss the special features met with in electric power plants in coal mines, and to give a record of difficulties and mishaps which have come directly before the notice of the author during the last ten years.

A great many of these plants are now in use, and are doing good work all over the country, lighting, pumping, haulage, and coal cutting being the principal uses to which electricity has been put.

Lighting—It is usual to employ a separate plant for lighting, as the lamps are required in the pit night and day. A pressure of 220 volts is usually employed for the lighting circuits, and from 500 to 800 volts for the power.

Underground engine rooms, which are at a considerable distance from the generating station, are often lighted from the power mains with several lamps in series. The light is generally very much appreciated, especially at the shaft bottom, and at landings where there is often a good deal of shunting carried on. Where the mine is dry, simplex steel tubing can be used to great advantage in places where there is not likely to be a fall of roof. There is an immense amount of primitive wiring in use, it being quite usual to run the wires on insulators and for the workmen to bare the two wires and hang a lamp across wherever they want it. This is, of course, only done in parts of the mine which are not fiery.

Enclosed arc lamps are very suitable for screens and pit heads, as well as for the pit bottom.

Generating Plant.—Very low steam pressures are usually employed at collieries, and, coal being comparatively cheap, the steam engines are often of a primitive pattern. Condensing plants are seldom used.

Old winding engines are very often employed, and have the advantage of being extremely reliable; as a rule, however, they do not govern at all well.

For power the units are usually from 100 to 200 I.H.P., and for lighting 50 I.H.P. In the best plants, Corliss and vertical engines, with fly-wheel governors, are employed. These drive the dynamos with ropes or belts.

Some of the best mines, however, are employing higher steam pressures, and vertical high-speed direct coupled sets.

The most important requirement is absolute reliability, as spare plant is seldom put down, and the machinery often works for at least 16 hours a day.

Generators.—Owing to the fact that non-condensing steam engines are used, there is always a great deal of steam about the surface works of a colliery, and this, combined with the immense amount of fine coal dust, covers everything with a film, which is by no means a good insulator.

For this reason it is not advisable to employ dynamos which have internal ventilating spaces, and in any case all insulating materials have to be of the very best quality.

The greatest care has to be taken with spare machines and armatures, as these are liable to get very damp.

The author has known armatures which were not suitably insulated to break down one after the other, and this is generally found to occur on damp days in January or February.

Exactly similar machines which were working underground, where everything was very dry, gave no trouble whatever.

The load on the generators is likely to be extremely variable, there being as a rule only two or three motors on the circuit, which may all be stopped at the same time. It is quite usual with haulage for the load to vary from 25 per cent. overload to open circuit in a very short space of time. It is, therefore, most important that the generators shall run without requiring any attention to the brushes. One man as a rule looks after a fan engine and all the electric light and power engines and dynamos, and if the machinery is suitable he has a very easy time.

Switchboard.—Owing to the atmosphere being charged with damp coal dust, the switchboard must be thoroughly insulated and must be fire-proof. In a switchboard largely adopted by the author, the slate slabs are thick and rest on a low wall of glazed bricks, the top being supported from the wall of the building by iron brackets. The only woodwork is a strip of teak along the top of the slates, fastening together panels of the same potential. The slates have the edges bevelled, and there is no wood or metal framework.

Owing to the fact that single armoured cables are generally used, any sudden break sets up an enormous tension on the insulation, and it is best to employ massive slow-break switches of the simplest character. A most important instrument for the switchboard is a megohmmeter, arranged to read direct the insulation resistance between either pole and the earth.

A log is kept of the insulation, and any leak put right as soon as possible. Where men's lives depend to a great extent on an absence of leakage, it is of the greatest importance that everything should be kept in first-rate order.

Cables.—For shaft work there does not seem to be anything better than Callender's armoured vulcanised bitumen cables, and when these are protected from falling objects and are kept well coated with Stockholm tar, they will last a very long time. The cables are almost always carried down the down-cast shaft, as the fumes and steam in the up-cast shaft are very injurious to the armouring. The cables should be so fixed that they will not be struck by any corves or other trifles which have a habit of falling down the shaft.

Underground cables are generally suspended from the props which support the roof; they are hung fairly slack and should be suspended by loops of yarn or leather and not nailed up with cleats. If thus supported, in case of a fall of roof, the cables fall to the ground, and are not so likely to be cut through.

Ordinary rubber and lead-covered cables are often used, but a good armoured cable is greatly to be preferred.

All joints should be made in proper joint boxes, as solder cannot be employed, and a single-pole switch should be fitted on each conductor wherever there is a junction. Double-pole switches should not be used, but single-pole coupled externally. These switches should be entirely lined with slate, and made so that there is no possibility of an arc being started to the case.

The switches should be made so that they will break the circuit with certainty in case of a short circuit.

Switch Gear for Motors.—Where the cables enter the underground engine room, they should be connected to two single-pole switches, similar to those mentioned in connection with the junctions.

It is most important that the shunt circuit of the motor should not be broken, as the extremely high tension at breaking causes a vicious spark and puts tremendous stress on the insulation. By far the safest plan is to connect permanently across the shunt coils a non-inductive resistance of about twice the resistance of the fields. The current used is very small, and the field circuit can be broken with impunity.

The author has known the shunt coils of a motor to be left on and to be broken by switching off at the surface, thus causing an enormous stress on the insulation of the mains. All series coils should also be fitted with a similar resistance. Precautions such as this reduce the flash from the switches, or, in case of a broken cable, to a very great extent.

Motor Starting Switches.—If a good double-pole break is arranged where the cables enter the engine room, a single pole starting-switch can be employed. This is rather important, as the parts of opposite potential are kept well apart. The author has employed liquid switches with a good deal of success; but it must always be remembered that, where they are used for regulating, steam is given off and ventilation must be allowed, so that leakage is not caused by the condensed steam.

In any case, all resistances should be made so that they will carry the full working current, as they are sure to be used some time or other for regulating.

The cones of liquid switches are of either iron or lead, and should be made so that they can be easily examined and replaced.

Where there is gas, all switches must be entirely enclosed.

Motor.—There appears to be a fairly general opinion that there is a great deal of danger from the explosion of gas ignited by the sparking at the brushes, and a number of experiments have been carried out which do not seem to have proved anything one way or the other. Whether this is so or not, it is perfectly obvious that the heat from a burnt-out armature or the arc from a broken circuit would be quite sufficient to ignite gas, and where there is any chance of gas being present it is necessary that the armature and commutator at least, if not the fields, should be enclosed in strong gas-tight cases. All the terminals should be made so that cables cannot be accidentally pulled out, and the machines should be of such construction that they will pull up at once in case of a bad leak or short circuit. It is well known that a Gramme armature will go on running for some time with a burnt-out coil, all the time doing itself a very great deal of damage and developing a great deal of heat. A drum armature, however, in which the conductors of opposite potential are close together, will stop at once if there is a short circuit in the armature, and if proper fuses are fitted the machine is at once cut out. This is a most important feature in this type of machine, and Gramme armatures should never be used for any underground mining machinery.

Totally enclosed machines are by no means in favour among colliery managers, as they are difficult to keep clean and to inspect, and the general opinion seems to be that an open machine is to be preferred, precautions being taken that the engine room is kept free from gas.

Enclosed machines are certain to be run some day with the covers loose or entirely off.

It is possible to obtain motors which will not break down and which do not spark at the brushes, and with careful supervision and an organised testing of the insulation from the switchboard in the generating station, there should be no danger from fire or explosion.

Pumping.—The advantage of electric motors for this work are obvious, and a large number of pumps are in use. Compound motors are generally employed, as they will not run away if the pump loses its water. Owing to the damp places in which they usually work, pump motors are often entirely enclosed, and shunt wound machines under these circumstances are apt to give trouble owing to the resistance of the fields rising as the machine gets hot. This increases the speed and the armature current. The addition of a fair amount of series winding prevents these difficulties from arising.

Haulage.—The author cannot quote a single instance in which

electric locomotives have been employed in coal mines. Wire rope haulage appears to be almost entirely employed.

With continuous rope haulage the motor usually runs at a constant speed, the rope pulleys being started and stopped by means of clutches.

With single rope, and main and tail, haulage the electric motor is shown to advantage, the smoothness of starting and complete control over the speed, as well as the ease of reversal, giving an extremely handy hauling engine.

Coal Cutting.—The motors employed for coal cutting are usually series wound, and are subject to extreme variations of load and to very great shocks. They are entirely enclosed, and are consequently liable to get very hot. It is, in fact, difficult to imagine a more trying load.

With these motors it is, of course, imperative that they should be entirely enclosed, both for the protection of the armatures from falling coal, and to keep out the coal dust.

It is most important that effective switches and cut-outs should be fitted at the junction where the motor cables are carried from the main cables, so that, in case of damage to the flexible cables or of burn out in the motor, both poles are quickly cut out.

Generally.—The amount of bad or unsuitable work to be found in colliery installations is very surprising, and it is apparently only due to the strict supervision and high order of intelligence to be found among those in responsible positions in collieries, that there are so few accidents.

With good work electric power transmission is an immense boon, and there should be a very great field for extensions.

As the author has not employed any multiphase motors in mining work, he is not in a position to discuss their use. Many of the points raised, however, will apply to both systems.

As one mishap gives more instruction than many years of steady running, a list is given herewith of a number of accidents and defects which have come directly before the notice of the author. For obvious reasons the actual localities are not given.

(*a*) *Engines.*—A stud sheared which fixed a fly-wheel governor in place. The engine ran away.

(*b*) *Dynamos.*—Three armatures broke down one after the other, stopping the pit for three days. The first armature broke down. The spare dynamo had not been run for several months, and on starting up burnt out. The spare armature had been kept in a damp place, and broke down at once. All these armatures were only insulated with compressed paper.

(*c*) The brushes for three dynamos cost £40 in one year, and armatures constantly broke down owing to over-heating. The brush-holders were originally few in number, with large carbon blocks. These were changed for a number of holders, each carrying a small block of carbon. After this alteration the machines ran well, and a set of carbons now lasts for many months.

(*d*) A number of instances of short circuits have occurred, owing to the ventilating spaces in the armature becoming filled with coal dust. The armatures often broke down after they had been standing for some time. The coal dust seems to absorb moisture.

(*e*) *Switchboard.*—An arc was started at 600 volts between two contacts about 1½ minutes apart at opposite potentials on a switch connected to a megohmmeter. The base of the switch was ebonite, and the leak was due to a fine layer of damp coal dust.

(*f*) In another case a voltmeter was entirely burnt out, evidently from the same cause.

(*g*) While there was a heavy earth on the mains an arc was started between a switch on the engine room switchboard, and part of the metal framework supporting the slate. This was evidently due to coal dust.

(*h*) *Cables.*—Two armoured bitumen cables were laid in a wooden trough, which was close to a leaking steam pipe. Both cables went to earth within a few hours of each other. The trough has since been filled with bitumen, and no further trouble has occurred.

(*i*) A nail fastening up a cleat had evidently been driven through an armoured cable, passing through the insulation but not touching the conductor. This finally came in contact with the conductor, and, as there was a bad leak but not a dead earth on the other pole, an arc was set up and a very serious fire only prevented by the fact that the assistant manager was close by, and telephoned to the engine-man on the surface to shut down.

(*j*) A common twin cable was carried down a shaft for lighting a mine. 60 volts were lost in this cable, the volts at the surface being 110, and in the mine 45 to 50.

(*k*) A runaway train of tubs cut through one of the cables. The accident happened close to a box containing a double-pole branch switch The drag on the cables broke the marble bases of the switch into several pieces, and an arc was started to the iron case.

A number of cases have occurred where runaway trains have cut the armoured cables clean through.

(*l*) *Motor Switches.*—Owing to there being no stop inside the switch, and the handle being put on the wrong way, a double pole switch was carried back too far, and a short circuit effected between opposite poles.

(*m*) A main regulating switch was not marked, and was arranged to switch off left-handed instead of right-handed. An accident occurred to the gear, and the attendant, instead of switching off, switched on to full speed.

(*n*) A double-pole enclosed switch was fitted with a fibre arm, The insulation of the fibre broke down and caused a short circuit.

(*o*) A single-pole enclosed switch had a cast-iron arm supporting the moving contacts. The arm broke in switching on, but the contacts remained in position. It was therefore impossible to switch off the current, as there was no double-pole switch fitted.

(*p*) A gas-tight cover to a liquid switch was fastened by cramps binding the porcelain jar very tightly. The jar cracked when it got hot, and caused a partial earth owing to leakage of the solution.

(*q*) Owing to insufficient room being allowed for a liquid switch gear, the steam from the solution caused an arc to be started between opposite poles on several occasions.

(*r*) A double-pole switch in the shunt circuit of a compound motor worked perfectly well on the surface when tested with its own motor. On being erected underground, at the end of several miles of armoured cable, the length of the break was not sufficient, and an arc carried on between the contacts.

(*s*) *Motors.*—In several cases a Gramme armature has gone on running with a short circuit in the armature, burning the armature to a cinder.

(*t*) No record has been found of a drum armature running on with a short circuit. Several cases have occurred in which the armatures have pulled up at once from a short circuit, the damage to the coils being very small.

(*u*) A cable was brought from the magnets of a large shunt motor to a switch in another part of the engine room. This cable was loosely run, and was accidently pulled out of the connection. A tremendous flash was the result, the commutator was badly damaged, and the fuses on the surface blown.

(*v*) The shunt circuit of a compound motor was broken, and the motor ran away.

(*w*) After some repairs the series coils of a compound motor were connected up the wrong way. The machine gave a great deal of trouble, and it was some time before the mistake was found out.

(*x*) A shunt motor driving a pump was driven by a shunt dynamo through a long line. The motor was enclosed, and the fields got very hot. The field of the motor being weakened, the current increased, and it was found to be impossible to run the plant for more than two or three hours at a time.

CORRESPONDENCE.

Prevention of Scale in Boilers.

During tea-hour on the "Heavy" a discussion arose on the practice of hanging zinc plates in boilers, and the probable action of the metal in preventing the formation of scale.

If this is due to hydrogen being evolved and collecting on the boiler plates, thus preventing the scale getting a "purchase," it occurred to some of us that this remedy could be effected easily and cheaply by hanging a block (say carbon) inside the boiler and passing a current from this to the boiler plates; the acids and insoluble matter in suspension permitting the electrolysis.

As it is mainly when the boiler is shut off that the scale seizes its chance of claiming an intimate acquaintanceship, this would be the best time to deposit a film of minute bubbles of hydrogen which, when fires were again lit up, would possibly expand and so shake off the scale.

D. MacB.

Rochester Electricity Works,
April 6th, 1901.

[The passing of a current through the boiler in the manner suggested is, we believe, a very old device.—Eds. Elec. Rev.]

Depreciation.

I am sure I ought to feel very highly honoured that you consider my letter worthy of nearly a whole page of a leading article, which has amused me considerably, as I find the most perfect answer to your article by reading my letter again, and for those who are anxious to digest the same, I would suggest that they first of all read my letter, then your article, and then re-read my letter again. It is very clear, if you argue for ever, that the sinking fund does not form a portion or the whole, as the case may be, of the depreciation fund necessary; you will not convince the Local Government Board, who especially provided *that* fund for *that* purpose, and for that reason fixed the period of 25 years, otherwise there would be no reason for fixing the time, period, or redemption so definitely.

To take a child's illustration of "beans." If I give you 10 beans, and you pay me back one bean per annum, which represents your sinking fund, it is clear that at the end of 10 years (neglecting, of course, compound interest) that you will be in the position to re-borrow a fresh 10 beans and use that 10 beans for carrying on the same business as you did before, or entering into other negotiations; in electricity

supply we prefer to carry on the same business as before, and having paid the whole cost of our machinery off, we are entitled at the end of that period to buy more to replace the depreciated article, if necessary, and therefore your answers to my questions are not complete.

Answer 1 should read "repayment of loans," so as to borrow another loan to buy fresh machinery to replace the worn out.

Answer 2, the capital being permanently provided, no provision is necessary for repayment, and therefore the capital cost of the machines which are worn out, must be written off at the end of its life, either by so much set aside every year, or by a lump sum at the last, taken out of the revenue account.

It apparently does not occur to you the extraordinary position a municipal undertaking would be in if it did not consider that the sinking fund *formed* part of its depreciation fund, as, given a capital which does not increase—say, £50,000—to be paid off in 25 years, at the end of that period you would have provided sufficient money to replace the whole of the plant (your depreciation) plus the value of that "scrap," in fact, you would be making a present to the ratepayers of 50 years hence of £50,000 plus the value of the plant at that date, as you have already paid off your loan which you borrowed to buy that plant (the additional £50,000 represents what you state is necessary for depreciation). If you cannot understand it now I must give it up as a bad job!

I may mention Sir William Preece was called in for a special report with respect to an injunction that was likely to be applied for for smoke and vibration during the year of the "Coal Famine," but the Council do not intend acting upon his report and spending the £10,000 you mention. The tables I have worked out refer to "Virtuous Glasgow" and "Wicked Tunbridge Wells."

The results may come somewhat as a shock, especially when one bears in mind also that "Virtuous Glasgow" last year charged a large sum—nearly 50 per cent. of its total engineering salaries—to capital account (a sum of £725!) but then Glasgow has no Government auditor. However, I am of the opinion (and the Government auditor agreed with me) that it is fair to charge a certain proportion of the engineers' salaries to capital account where those engineers carry out extensions, and where no consulting engineer is employed—as is the case at Tunbridge Wells—as it must be evident that a large *proportion of their time* is expended on *these* extensions, and had they a consulting engineer and clerk of works employed, I do not think you would be prepared to question the right of charging the consulting engineer and the clerk of works' fees to capital account. However, the matter is so small in the case of Tunbridge Wells—representing only £262, although we were spending £25,000 during that year—that enough has been said of charging part of the engineer's salary to capital, and it would be better if a few more facts were given by outside people who endeavour to misinterpret the truth. Then you speak of a fair proportion of salaries and establishment charges, amounting to £250. I have scanned very carefully the Glasgow accounts, and cannot find a proportion of the town clerk's, borough accountant's, of the rate collector's, or the general Town Hall expenses charged in the revenue account, whereas "wicked Tunbridge Wells," although it has only a capital outlay of some £42,000, has had to contribute the sum of £250 per annum, plus £48 for rate collecting, making in all £298 odd—and here, again, I think you will admit we are improperly used compared with companies and other local authorities.

It is somewhat amusing that the men's names mentioned in your article may "talk," but not one of them has "acted," in connection with companies or local authorities they are connected with, on what they *think* is correct!

I do not find the City company has set aside 5 per cent. I do not find any concern Mr. Hammond is connected with has set aside sufficient to buy new plant in 15 years. I do not find even Mr. George Offor and the old "Crystal Palace and District Company" have carried out his ideas! It must, therefore, be the old idea, that "It is easier to preach than to practice." But I do not believe in quoting men's statements unless those statements are put into practice by themselves.

"Wicked Tunbridge Wells."

Year.	Capital outlay.	Sinking fund, reserve, depreciation, &c.	Balance being profit of loss.	Price charged per B.O.T.	Price of fuel per ton.
1st.	£23,920	£691	£1,628	6d.	21/-
2nd.	31,275	697	1,632	5·7d.	21/-
3rd.	37,818	834	2,172	5·7d.	20/9
4th.	42,843	1,143	765	4·74d.	26 to 32/-
		£3,365	£6,197 profit.	5·28d. aver.	
	Add profit	6,197			
		£9,562 = Reserve, sinking fund, and depreciation in the aggregate of 22·3 per cent. on the capital.			

"Virtuous Glasgow."

Year.	Capital outlay.	Sinking fund, reserve, depreciation, &c.	Balance being profit or loss.	Price charged per B.O.T.	Price of fuel.
1st.	£96,697	£2,128	£1,773 loss.	7d.	About half the cost of fuel in Tunbridge Wells.
2nd.	116,585	5,593	607 „	7d.	
3rd.	131,764	6,481	1,527 „	6d.	
4th.	131,961	7,645	2,380 surplus.	6d.	
	£477,007	£21,847	£1,527 loss.	Av. = 6¼d.	
	Deduct net loss ...	1,527			
		£20,320 = Reserve, sinking fund, and depreciation, in the aggregate of 4·2 per cent. on the capital.			

Referring to the tables containing the accounts for the first four years of the Tunbridge Wells and the Glasgow undertakings, no words from me are necessary, as the facts and figures speak for themselves. However, it will be seen that, taking into account the money earned by the two undertakings, Tunbridge Wells has earned 22·3 per cent., whereas Glasgow (charging a higher price per unit) has only earned 4·2 per cent.

Horace Boot,
Consulting and Resident Engineer.

Tunbridge Wells,
April 1st, 1901.

[It would perhaps be an act of kindness to allow Mr. Boot to retreat under cover of his shower of beans, especially as he admits the whole case when he says "it is very clear" that the sinking fund does not form a depreciation fund.

The simple question is as to what constitutes a profit available for the relief of rates? Our contention is that before any contribution to the rates can be properly made, the depreciation of the plant must be taken into the account, and that it cannot form any part of the sinking fund provided for repayment of money spent on its original cost.

It does not in any way affect the question whether the Glasgow accounts or those of private companies have always carried all they ought to revenue instead of to capital account—two blacks will not make a white—but if Mr. Boot's contention is right as to Glasgow, it only proves that the financial results there were not quite so favourable as £40 to the good at the end of the eighth year. Meanwhile it is sufficient for our purpose that the business men of Glasgow consider that 4 per cent. for a depreciation and renewal fund is a proper charge to make against revenue.

Mr. Boot's figures at the end of his letter do not touch the question.

We have summarised the results of the trading down to March 31st, 1900, and they appear to show that there was an amount of £1,550 9s. 4d. to be provided for, if depreciation at 4 per cent. is allowed, and the special items objected to by the auditor transferred from capital to revenue account.

We must leave the Council to settle the question with Sir Wm. Preece as to the smoke and vibration. We can only congratulate the ratepayers, if there is no necessity for adopting the expert's advice, and they so save £10,000.

It would be interesting to have a report from the borough

accountant, showing the actual results of the electricity supply speculation from the commencement to March 31st last.—Eds. Elec. Rev.]

The Briton and his Commercial Rivals.

Without having made any deep study of political economy, I think one may see that the optimistic conclusions deduced by Mr. Broomhall in his letter, published in your issue of March 29th, are very unfounded. Mr. Broomhall's statement is, I take it, this. One British workman produces for export a value in merchandise greater than the combined products, for export, of one man in Germany and one man in America. Before we can deduce any conclusion as to the prosperity of the country, however, we must know the value of the imports on the same basis. If the value of our exports is greater than our imports, then we are lessening our indebtedness to foreign countries, or acquiring capital in them, thus gaining a commercial ascendency over them; or we may be accumulating gold in the country to be used at a future time to buy goods from foreign countries. If our imports are greater than our exports, we are allowing foreigners to obtain control of our capital, and, indeed, sinking into commercial serfdom, no matter how great the actual amount of our exports may be. The absolute value of the imports and exports only serves to indicate the industrial conditions we are working under, and all that can be deduced from Mr. Broomhall's statement seems to me to be that the British workman is more dependent upon foreign trade than either his German or American rival, and is becoming even more so. A complete statement giving the imports and exports of a country would still be by no means conclusive, since this would give no idea of the internal trade, which is the chief part of the total trade. This internal trade is greater in proportion in Germany and America than in England. The sum of the values of the internal and foreign trade, *per capita*, would be a much fairer basis to deduce the prosperity of a people from, for this would show how much each was consuming and producing, and, so to speak, the rate at which he was living; but even then a frugal people might be really more prosperous with less trade than a people of extravagant habits.

Percy Matthews.

Manchester, *April 6th*, 1901.

["Disgusted One."—You have not sent your name and address. Such should always be forwarded with letters intended for publication.—Eds. Elec. Rev.]

LEGAL.

Metropolitan Electric Supply Company *v.* Gender.

In the Chancery Division of the High Court of Justice on 2nd inst., Mr. Astbury, K.C., on behalf of the plaintiff company, applied to Mr. Justice Buckley for an injunction to restrain the defendant until the trial from taking energy for lighting his premises in Holborn from any other electric supply firm. Counsel explained that the defendant entered into an agreement with the company to take the whole of the electric energy required for his public house from the plaintiffs for a period of five years. The charge was to be 4½d. per unit. Notwithstanding that agreement, the defendant had entered into an arrangement with the County of London Electric Company for the supply of energy for his premises. The affidavits that had been filed, the learned counsel represented, contained certain rather gross statements by the defendant, who declared that the energy was so bad at times that his lamps would not give any light, and that at other times the energy was so great as to destroy many of the lamps. There was evidence from other parties whose premises were supplied with energy on the same circuit, and that evidence showed that the electrical supply was efficient. The affidavit of the secretary of the plaintiff company set forth that the usual charge for the supply of energy was 5d. per unit, but a reduction was made if the supply was taken for a number of years. In September, 1900, the defendant in breach of his agreement ceased to take his supply from the Metropolitan Electric Supply Company, and began to take it from the County of London Company, a company which had also power to supply energy in Holborn. Thereupon the solicitors of the plaintiff company wrote the defendant, pointing out that the agreement had been broken by him. After the writing of this letter the defendant again took the supply of energy from the plaintiff company, but on February 25th last a letter was received from him, setting forth that he was dissatisfied with the light and that he had instructed the other company to supply it. The letter concluded with the statement that the defendant would feel obliged if the plaintiff company would remove its meter from his premises. The meter was not removed by the company, which was ready and willing to continue its supply of electrical energy to defendant. The affidavit of defendant set forth that on November 1st, 1898, he entered into possession of the premises. On November 16th of that year a representative of the plaintiff company called upon him and induced him to consent to the supply of energy. His attention, he asserted, was not called to the clause setting forth that the agreement was to be for five years, and he was not aware of it until November, 1900, when his daughter showed him it on receiving plaintiffs' letter. From the time he took possession of the public house he was continually calling attention to the unsatisfactory light. Not only was the pressure low, but there would occasionally be sudden flashes, with the result that numbers of the lamps were destroyed. At least 20 lamps were destroyed in this manner. He further represented that owing to the deficient supply of energy he was compelled to remove the arc lamp outside his premises and replace it by a gas lamp. As the plaintiff company would not disconnect their service at his request, he applied to the County of London Company for a service. Afterwards he allowed the plaintiff company to restore their service, but again the supply was very bad, and he had to make many complaints to its representatives. The defendant further declared that on receiving no reply from the plaintiff company in answer to a complaint he addressed to them, he applied to the County of London Company for a supply of energy. He was now obtaining that supply, which he found was satisfactory. If he were to be restrained from obtaining energy from the County of London Company defendant represented that he would probably have to light his premises with gas. Counsel thought his Lordship would come to the conclusion that there was no cause for complaint by the defendant. The affidavit appeared to him to be made at the instigation of the rival company. The affidavit of a barman engaged in the public-house owned by the defendant was to the effect that the electric light was bad and uncertain. It frequently failed and gas had to be resorted to. The superintendent of the canvassing and contract department of the plaintiff company in his affidavit said that no complaint had been made to him by the defendant concerning the supply of electrical energy. Defendant had told him that he had no reason for ceasing to take the supply other than that the County of London Company's canvasser had become such a nuisance that he had decided to take the light from that company to save further trouble. Defendant also told him that the canvasser of that company had represented that if he agreed to take the supply of energy from him, the County of London Company would see him through in the event of any litigation. Mr. Wright, a canvasser in the employ of the plaintiffs, in his affidavit, spoke to the agreement he had made with the defendant. The agreement that the supply was to be taken for five years, and that the price was to be 4½d. per unit, was left with the defendant for signature, and he returned it by post. It was distinctly understood that the agreement was to be for five years. No complaint was ever made to him of a defective supply of energy. Mr. Todd, the chief engineer to the plaintiff company, stated in his affidavit that during the time defendant received his supply of energy, the pressure had been uniformly good. He was quite unable to understand the various failures of the energy alleged by the defendant. Any failure of energy affecting his premises would have affected the supply to the Royal Music Hall, Holborn, and no complaint had ever reached the works of such a failure. The affidavit of the proprietor of the Royal Music Hall, Holborn, was also read. He stated that since the end of November, 1898, the light supplied by the company to the music hall was of the most satisfactory character in every respect. The learned counsel submitted that, in view of this evidence, the defendant's contentions could not be upheld. The plaintiff company contracted to supply an article of commerce for five years at 4½d. per unit, and if the company had within that time disconnected that supply of energy for some other reason than non-payment, he would have been clearly entitled to an injunction to restrain the company from ceasing to supply energy for lighting his premises. Defendant did not say that he did not require electric energy for his premises because he was now getting it from another company.

Mr. Sargeant, who also appeared for the plaintiff company, said he quite agreed that they could not require defendant to take a single unit of electrical energy from them if he chose not to use electric energy in his premises, but, if he required such energy, the Metropolitan Electric Supply Company was the only company which should supply it.

Mr. Stewart Smith, for the defendant, explained that his case was that the supply of energy from the plaintiff company was so defective that it had to be discontinued.

His Lordship thought the action should be set down for trial at once.

Mr. Astbury, K.C., thought his learned friend ought to give particulars of the dates on which he was going to allege deficiencies of supply.

Mr. Smith said he would give the best particulars he could, but he could not specify to a minute.

His Lordship agreed that the case should be set down for trial on or before May 24th.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending April 3rd, 1900.		Week ending April 2nd, 1901.	
Adelaide	Value £30	Adelaide	Value £593
Alexandria	92	„ Teleg. wire	743
Amsterdam	300	Alexandria	107
Bombay	37	„ Telephones	54
Buenos Ayres. Teleg. mat.	178	Amsterdam	35
Calcutta	430	Auckland	91
Cape Town. Teleg. mat.	3,693	Bilbao	30
Colombo	91	Brisbane	425
Copenhagen.	61	Buenos Ayres	57
„ Teleg. mat.	115	„ Teleg. mat.	291
Demerara. Teleg. cable	261	„ Teleph. cable	336
Durban	548	Calais	58
„ Teleg. mat.	584	Calcutta	533
Gothenburg. Teleg. mat.	77	„ Teleg. wire	86
Hamburg. Teleg. mat.	810	Cape Town	42
Hiogo	190	„ Teleg. mat.	1,198
Kobe	146	Chinde	42
Lytteiton	251	Christiania	59
Malta	21	„ Teleg. wire	51
Melbourne	321	Colombo	67
Monte Video	633	Durban	795
Penang. Teleg. apparatus	310	East London	536
Port Elizabeth. Teleg. mat.	281	Fremantle	21
Port Said	24	Hamburg	147
Reval	89	Hobart. Telephone cable	268
Rotterdam. Teleg. mat.	400	Kobe. Telegraph cable	6,534
St. Petersburg. Teleg. mat.	250	Kure	83
Seville	270	„ Teleg. cable	2,471
Shanghai	195	Leghorn	17
Singapore	61	Madras	8
Sydney	1,080	Malta	88
Trinidad	31	Melbourne	200
Wellington	128	„ Telegraph cable	1,483
„ Teleg. mat.	470	Paris	65
Yokohama	350	Perth	153
		Port Elizabeth	1,454
		Rio Janeiro. Teleg. mat.	68
		St. Helena	35
		St. Petersburg. Teleg. mat.	300
		Shanghai	165
		Singapore	32
		Stockholm. Teleg. wire	691
		Sydney	3,081
		„ Teleg. wire	1,654
		Valparaiso. Teleg. mat.	61
		Wellington	820
		„ Telephones	2,770
Total	£12,808	Total	£28,848

Foreign Goods Transhipped.

St. Petersburg. 14 tons teleg. wire —	Cape Town. Elec. Light Appar. value £20

Electrical Wares Exported.

Week Ending April 10th, 1900.		Week ending April 9th 1901.	
Adelaide	Value £81	Adelaide	Value £42
„ Teleg. mat.	152	„ Teleg. wire	129
Amsterdam	355	Bombay	97
Brussels	12	Brisbane	68
Calcutta	1,443	Calcutta	411
Cape Town	59	Canada (*via* U.S.)	180
„ Teleg. mat.	2,412	Cape Town	105
Channel Islands	19	„ Teleg. mat.	80
Chinde. Teleg. wire	124	Channel Islands	17
Christiania. Teleg. wire	62	Christiania. Teleg. mat.	91
East London	112	Colombo	190
Gibraltar	60	„ Teleg. mat.	54
Gothenburg. Teleg. wire	158	Copenhagen. Teleg. wire	34
Hamburg. Teleg. mat.	400	Delagoa Bay	91
Lisbon	25	Durban	105
Madras	535	East London	24
Malta	18	Gibraltar	158
Mauritius	20	Gothenburg. Teleg. wire	226
Melbourne. Teleg. wire	1,605	Hamburg	25
Ostend	167	„ Teleg. mat.	250
Rotterdam. Teleg. mat.	200	Hong Kong Teleg. mat.	120
Rouen	60	Lyttleton	60
Shanghai	166	Madras	766
„ 67 tons old teleg. wire	—	Malta	16
Singapore	122	„ Teleg. mat.	131
„ Teleg. mat.	179	Melbourne. Teleg. mat.	576
Sydney	1,824	Monte Video. Teleg. mat.	24
„ Teleg. mat.	170	Perth	85
Wellington	367	Port Elizabeth	963
		Port Said	17
		Rangoon	11
		Rouen	55
		Shanghai	423
		Singapore	222
		Stockholm. Teleg. wire	247
		Sydney	207
		„ Teleg. wire	1,170
		Taku. Teleg. instruments	108
		Tokio	32
		Vigo. Teleg. paper	352
		Yokohama	156
		„ Teleg. apparatus	170
Total	£10,407	Total	£8,187

Foreign Goods Transhipped.

Perth. Elec. goods Value £201	Durban. Telephones Value £36

Bankruptcy Proceedings.—A receiving order has been made against G. I. Lloyd, electrical and mechanical engineer, Bristol, on a creditor's petition. First meeting, April 12th; public examination, April 19th.

A second and final dividend of 1s. 6½d. in the £ is payable on April 17th in *re* E. J. Patterson and C. F. Cooper.

A first and final dividend of 2s. $\frac{1}{10}$d. in the £ is payable on April 4th in *re* L. Francis, electrical engineer, Southwold.

Last week the first meeting in *re* A. J. Greenberg (Midland Electrical Company), was held at Birmingham. It was stated that there was very little prospect of any dividend, for the effects had only realised a little over £30. There were a few book debts, and a deficiency of nearly £800.

Dissolutions and Liquidations.—The Auto-Electro-Feed Water Purifier Company, Limited, of Wolverhampton, is winding up voluntarily, with Mr. H. P. Smith as liquidator.

Messrs. A. Allen, H. F. Ward, and J. Harrison (Allen, Ward and Harrison, electrical engineers and millwrights, Warstone Lane, Birmingham), have dissolved partnership so far as concerns Mr. Harrison, who retires. The business will be continued by the two remaining partners as Allen and Ward.

A petition for the winding up of the National Company for the Distribution of Electricity by Secondary Generators Limited, will be heard on April 17th before Mr. Justice Wright. Petitioner: A. Scott, 5, Canonbury Place, N.

A similar petition respecting the British Electrozone Corporation, Limited, will be heard on the same day. Petitioners: Ede and Allom, printers, &c., Maiden Lane, Cheapside, E.C.

The Electrical Vehicle Syndicate, Limited, meeting at 6, Old Jewry, E.C. is winding up voluntarily with Mr. Alfred Holmes, Portland Road, Newcastle-on-Tyne, as liquidator.

A meeting of the Sandycroft Foundry and Engine Works Company, Limited (in liquidation), will be held at 6, Queen Street Place, E.C., on May 6th, to receive the report of the winding up from the liquidator (Mr. F. H. Williams).

Blast Furnace Gases.—What is described as the first Austrian-built gas engine operated by the waste gases of blast furnaces has just been completed by Messrs. Breitfeld, Danek and Co., of Carolinenthal, Prague, and installed at the Königshof iron-works of the Bohemian Mining Company. The engine, which is built on the Delamere-Debouteville system, is capable of developing 300 H.P., and is directly coupled to a continuous-current dynamo constructed by Messrs. Kolben & Co., of Prague, the plant supplying current for lighting and power purposes.

Catalogues and Lists.—Messrs. J. H. Sankey & Son, of Canning Town, send us circulars of their fire and acid resisting bricks and other fire goods.

Pamphlet No. 91, issued by the B.T.H. Co., describes their type R magnetic blow-out controllers for electric cranes, hoists, mine haulage, &c., and type S ditto for electric launches and automobiles.

Those who are following the subject of street electric lighting will find a little booklet issued by the Improved Electric Glow Lamp Company, Limited, of interest. It is entitled "Street Lighting."

The Electrical Company, Limited, have issued a reference list of their dynamos and motors for direct and single and three-phase alternating current; also quick-break knife switches up to 500 V.; insulation testing set; and alternating current induction instruments.

The Unbreakable Pulley and Mill Gearing Company is circulating a leaflet relating to its wrought-iron pulleys and swivel bearings.

Electric Motor Cars.—M. Garcin, of the firm of Messrs. Buguet, Garcin & Schivre, last week made a long-distance run on a light electric motor car, covering a distance of 85 miles in 6 hours 32 minutes 55 seconds on the Paris-Mantes road, and on one charge of the batteries. The car complete weighed only 730 kilogrammes (14 cwt. 38 lbs.), of which 334 kilogrammes (6½ cwt.) consisted in the battery of B.G.S. accumulators having a capacity of 120 ampere-hours. The run is said to be a record for such a light car.

Electrical Engineering Works at Stafford.—Messrs. Siemens Bros. and Co. have completed the purchase of land required at Stafford for the erection of extensive works for electrical construction purposes. Testings have been going on for some time in the locality, with the result that the company have acquired between 60 and 70 acres, admirably situated as regards railway facilities, the London and North-Western railway skirting the whole of the property. Plans for the building operations, which will soon be commenced, are being prepared for submission to the borough authority, and the company propose to erect about 1,000 dwellings for the accommodation of their employés.

Electrical Trust in Canada.—The *Morning Post* Montreal correspondent says that the Montreal Heat, Light, and Power Company is organising an immense trust for the purpose of monopolising all the electric power and gas business in and about Montreal. The capital of the trust is $25,000,000. The promoters say they can make electrical power cheaper in Montreal than in any other place in the world. Immense new dams are being built at Chambly, and there will be an increase of from 8,000 to 30,000 H.P. in the power houses within two months. One of the directors of the company has been attending to the financial part of the project in London.

Glasgow Exhibition.—The Irish section of this exhibition will be entirely lighted on the "E.L.B." system, the scheme including the outlining of the hall and many decorative devices, such as shamrocks, &c. The whole of the work is being provided by the Electric Lighting Boards Company, and is being installed by Messrs. Wm. Coates & Son, of Dublin and Belfast.

"Insurance Engineering."—This is the title of a new monthly magazine published in New York. Its objects are thus described: "Devoted to the science of diminishing hazards to property and life," and it is intended for underwriters, architects, builders, public officials, and fire departments. The first number (April, 1901) is a very presentable and interesting production. One

of the best articles from the electrical point of view is that titled "Some Characteristic Electric Burn-outs." It gives some illustrations showing what the jerry wireman can do when he is left alone.

Light Railways.—The L.R. Commissioners have submitted to the B. of T. for confirmation the Barnsley and District Light Railways (Extensions) Order, and the Llanelly and District Light Railway Order.

Niagara.—The Castner Electrolytic Company has made a contract with the Niagara Falls Company for 5,000 additional horse-power. This English syndicate recently purchased the plant of the Mathieson Alkali Works, which is now using 2,000 E.H.P., so that when the contemplated extensions are completed the Castner people will be using 7,000 E.H.P. in their Niagara plant. The extension will be made on the east side of the present works, and will consist of several brick buildings. When the plant has been completed according to present plans it will cover about 10 acres. At present the company employs about 250 hands, but when the new power contract is brought into service it is expected that the pay roll will reach 700 hands. The present output of the company in Niagara Falls is about 300 tons of caustic soda and bleaching powder a week, but with the new buildings and installation in service, the output will reach 1,000 tons a week. Thus the plant will be trebled in size and output, also in the number of hands employed. There seems to be a wonderfully brisk demand for Niagara electrical power. In addition to this big contract, the Niagara Falls Power Company has made a contract with the Natural Food Company for 2,500 E.H.P. to be used in the operation of a magnificent large new factory now in course of construction. Another contract has been made with an emery wheel company for 1,000 E.H.P. for the operation of a plant to be located just a little to the east of the Castner works. The Niagara Railway Supply Company has been incorporated to do business at Niagara Falls with a capital of $500,000: This company has selected a site on the lands of the Niagara Falls Power Company at the foot of Iroquois Street, where the McPherson safety frog and switch and other railway supplies will be manufactured. This is Niagara's first iron industry, and it is destined to be a very large plant. One of the directors is DeLancy Rankine, brother of William B. Rankine, and associated with him are Charles H. Huntley and Robert W. Pomeroy of Buffalo. The plant will use a big block of power, which will be supplied by the Niagara Falls Power Company. This, says our Niagara Falls correspondent, who sends the above notes, is the record of Niagara's advancement for a single week.

Personal.—Messrs. E. P. Allam & Co., of Hatton Garden, ask us to state that Mr. H. Greenway, traveller, is no longer in their employ.

Steel.—The Duke of Devonshire did his level best to maintain a cheerful demeanour at the meeting of the Barrow Hematite Steel Company, held at the Westminster Palace Hotel on 2nd inst., but the statement which he laid before shareholders bore anything but a rosy aspect. He said there had been a distinct slackening in regard to the output of iron and steel. The company, however, got its fair share of orders. The directors knew of all the orders on the market; and it might be a surprise to some of the shareholders that during the year 1900 the total quantity of rail orders coming out on the British markets was not quite 50 per cent. of what it was in each of the years from 1896 to 1899. He was not putting this in a pessimistic way, because there might be many causes for the falling off. Although foreign competition did, of course, account for a substantial part of the decrease of orders for English working, it did not by any means represent the total. The decrease, therefore, meant that either less rails were required, or that buyers held back in the hope thereby of saving something in the price. As regarded the general prospects of the company, he would not attempt to prophesy. The condition of the iron and steel trade was certainly not what they could wish it to be. They heard of great combinations being formed, accredited, he believed, with the intention of making still further inroads upon our trade, and it was difficult to see the end of all this. Nothing, however, was likely to be gained by panic. They could only do their best by keeping the works in good condition, by improving them where they could, and by economies, and in other ways putting themselves in the best position to meet the situation.

The Thames Ironworks Company and Electrical Industry.—At the annual meeting of the Thames Ironworks, S.B. and Engineering Company, Limited, last week, Mr. Arnold Hills, after dealing with the general engineering departments, proceeded to refer to the electrical department which he believed would become a big feature of their industrial system. He said that they had now arranged with Messrs. Siemens Bros. & Co., Messrs. Mather and Platt, and the Brush Electrical Engineering Company, to form an English combination, which would successfully hold its own against the German and American combinations. Now that the combination had been formed in this country, he saw no reason why electrical engineers here should not hold their own successfully against all competition. At all events, they had prepared designs for the electrical equipment of the Metropolitan District Railway and the Great Northern and City Railway, and they also had a scheme in hand for a railway from the north-east of London to the Monument, and from the Monument to Piccadilly. If these schemes bore fruit, there was no fear of their electrical department not being full of business.

The *Daily Mail* has made inquiries and learns that no actual amalgamation has taken place.

For Sale.—The Salford Electricity Committee invites offers for the sale of 4,000 incandescent lamps. See "Official Notices" to-day.

Trade Announcements. — Mr. John H. Calvert, electrical engineer, of Belfast, announces that he has taken into partnership Mr. A. Munro Taylor, of Glasgow. The business of electrical and mechanical engineering will be continued as usual at 30, Green Street, Belfast, under the style of "Calvert & Taylor." Mr. Taylor has had experience under the Glasgow Corporation in their electrical department. Mr. J. Coventry I'Anson, 52, Holland Road, Kensington, W., is the firm's London agent.

ELECTRIC LIGHT AND POWER NOTES.

Alfreton.—The B. of T. has recommended that the U.D.C. should limit the prov. order for the supply of electricity, for which it is applying, to the Alfreton Ward only.

Barry.—The B. of T. has granted a prov. order for electric lighting to the U.D.C.

Carnarvon.—The B. of T. has decided not to grant a prov. order to Mr. Peterson for the electricity supply of Carnarvon.

Cheltenham.—An inquiry was held by Colonel Langton Coke last week into an application for a further loan of £6,150 for electric light purposes. Up to the present £110,000 has been spent. The present application is to provide additional plant (including two traction generators), and for main extensions.

Croydon.—The County Council has sanctioned an estimate of £3,500 for arc lighting during the current year. The estimate for the public gas lamps which remained was £7,800.

Derby.—The T.C. has decided in future to charge 1¼d. per unit for electrical energy for motive power, in cases where consumers use the maximum demand for an average of over 50 hours per week. This change will secure one customer, whose bill alone would be £300 a year. At present private consumers are charged 5½d. per unit.

Dudley.—The Corporation electricity undertaking has generated 147,823 units during the last quarter, 108,000 more than during the corresponding period last year. After paying all charges, there is a net deficiency on the first two years' working of only £14.

Fulham.—The Board of Guardians has adopted Mr. Medhurst's scheme for lighting the Workhouse with electricity.

Hampton Wick.—In consequence of the failure of the Richmond Electricity Company's extension scheme, the U.D.C. has decided to approach the London United Tramways Company with a view to the lighting of the district from the company's generating station.

Hebden Bridge.—An electric light and power installation has recently been put into the clothing factory of Messrs. Broadbent Bros. & Blackburn, at Hebden Bridge. The plant was put down by Mr. R. S. Blackburn, of the same town. The old boiler house has been arranged for the reception of the electric generating plant. Two Otto gas engines (Crossley's) of 6 and 10 H.P. respectively drive two compound-wound dynamos, each capable of giving out 109 amperes at 100 revolutions, when running at 1,000 revolutions per minute. The switchboard, designed by Mr. Blackburn, is of enamelled slate, and cased in pitch pine. About 150 lights are installed in the works. The first circuit for power application leads to the basement or ground floor, where a ½-H.P. motor is applied to a direct-driven pumping plant. A 3-B.H.P. motor works a passenger and goods hoist capable of lifting about 10 cwt. at a speed of 60 feet per minute. This motor is placed on the top floor, and is connected direct to the hoist gear. On the same top floor is a 6-H.P. motor, driving two cutting-out band knives; it is also made to run the driving gear of the crane for loading and unloading all goods to the weight of 15 cwt. In the machine room below electricity is made to run about 80 sewing machines, and to drive revolving brushes for cleaning off any fluff or dust on garments. Mr. Blackburn added that the installation had been running six months, and there had practically been no stoppage except through the lack of gas.

Horsham.—The L.G.B. has sanctioned the borrowing of £14,000 for electric light purposes by the D.C.

Hoylake and West Kirby.—The Electric Supply Committee of the D.C. is instructing its consulting engineer to submit a scheme to provide for the lighting of the public lamps by electricity. The Committee has recommended the D.C. to apply to the L.G.B. for sanction to the borrowing of £12,000 for electric lighting purposes.

Huddersfield.—The T.C. have reduced the charge for electric energy for motive power to 1d. per unit, provided that customers' appliances will use equal to three-quarters of their full load for eight hours per day, 300 days per annum.

Ilfracombe.—The D.C. has accepted Messrs. Edmundson's terms for acquiring a prov. order for electric lighting.

Ilkley.—The D.C. has purchased the electric lighting prov. order, obtained by Mr. Gibbings, for the sum of £150.

Llandilo.—The D.C. has received sanction from the L.G.B. to borrow £4,000 for electric lighting.

Kimberley.—The charges against the private electric lighting system for the months of January and February exceeded the amount of the earnings by something over £400. A committee was appointed by the Borough Council to inquire into the matter.

Lahore.—The Bombay Tramway Company is negotiating with the Lahore Municipal Committee for a concession of the monopoly of the supply of electric light and power within the municipal limits for 30 years. Their proposals also include an electric tramway between the city and the railway station, with possible extension to Mian Mir.

Linlithgow.—The T.C. is considering an offer of the Crompton Electric Lighting Company, Limited, to obtain a prov. order for the supply of electricity in the burgh.

London, E.C.—The underground station of the City of London Company, at Nicholas Lane, was seriously damaged by fire on 2nd inst.

The L.C.C. has decided to lend the Stepney Borough Council £10,000 for electric lighting.

Ludlow.—The T.C. has adopted a report drawn up by Mr. J. Parker, of Hereford, proposing the electric lighting of the borough on the three-wire direct-current system, at an estimated cost of £7,350.

Morley.—The proposed extension of cables has been approved by the T.C., and an application is to be made to the L.G.B. for sanction to borrow £7,050 to carry out the work.

Motherwell.—The T.C. has decided to extend the system of arc lighting, and to reduce the prices to consumers of 20,000 to 50,000 units per quarter from 2½d. to 1½d. per unit for power.

Nelson.—Mr. A. H. Gibbings has been retained as consulting electrical engineer of the Corporation at £450 a year.

Norway.—The town of Drontheim, in the north of Norway, is following the example of Hammerfest and Tromsö by being provided with a central electric lighting station. The work is being carried out by Messrs. Schuckert & Co., of Nuremberg, and Messrs. Siemens & Halske, of Berlin, the former supplying and equipping the primary and secondary stations, and the latter the conductors, mains and transformers. The water-power of the Lerfossen Falls, about five miles from Drontheim, is to be utilised. The station will be at first equipped with two 1,000-H.P. generators, but it is being built with the idea of eventually being extended to 12,000 H.P. An electric tramway is also to be constructed in the town, the contract for this work having been secured by Messrs. Siemens & Halske.

Peterboro'.—On behalf of the L.G.B., Mr. K. North conducted an inquiry last week into the application of the T.C. to borrow £12,200 for the purpose of electric lighting.

Radcliffe.—The D.C. has decided to spend £81,000 on electric lighting and tramways.

Southend.—Last week Lieut.-Col. A. C. Smith, R.E., inspector of the L.G.B., held an inquiry with reference to the application of the T.C. for sanction to borrow £40,030 for the purpose of electric lighting.

Springhead.—The D.C. has decided to obtain a provisional order for electric lighting.

Stourport.—The U.D.C. has decided to apply for a prov. order for electric lighting.

Tynemouth.—The electricity works were formally opened by the Mayoress last week in the presence of a number of councillors and visitors. The plant includes three Lancashire boilers, fitted with superheaters and economisers; three 300-H.P. Belliss engines, coupled to Holmes and Westinghouse dynamos, and a Klein cooling tower. The plant is capable of supplying 15,000 lamps, and an additional 1,000-H.P. set is on order. Messrs. Lacey, Clirehugh & Sillar are the consulting engineers, and Mr. C. Turnbull, resident engineer.

Yorkshire Electric Power Company.—A conference was held at Dewsbury last week between representatives of local authorities in the district and directors of the Yorkshire Electric Power Company. Manufacturers and colliery owners were also present. Mr. A. G. Lupton, chairman of the company, presided, and described the company's objects.

The Dewsbury Chamber of Commerce has decided to support the Yorkshire Company's scheme.

ELECTRIC TRACTION NOTES.

Aberdeen.—The Corporation is about to ask for offers for the construction of a new electric station for the city at Dee Village, a property which they acquired some time ago. The new station is expected to cost, altogether, about £100,000, as due provision will be made for possible future large extensions of the electric system. Important extensions of the city electric car service are already in progress. A new line is in course of construction from the centre of the city to the Links. This extension will be worked by the trolley system, which is already in operation on another section of the service between the centre of the city and Woodside, a distance of about two miles. The Corporation, however, have in view a different system for the city car service, having entered into an arrangement with the American firm, Messrs. McIlroy and Grunow, to lay a section of line to be worked on their contact system. This section will be purely experimental, and will extend from the western edge of the Links, at Constitution Street, to the sea beach, a distance of about 400 yards. If the Corporation are satisfied with the system they will retain it, paying the company a certain sum for it; but if, on the other hand, they are not satisfied, it will be removed at the expense of the company. Should the Corporation find themselves satisfied with Messrs. McIlroy & Grunow's system, it is probable that they will adopt it for the other extensions in contemplation. It is expected that this test section will be in working order in the course of a month or two.

Ayr.—Satisfactory progress continues to be made with the laying of the rails for the electric tramways between Ayr and Prestwick. It is hoped to have the line in operation before the end of the forthcoming season.

Batley.—Mr. Clirehugh, consulting engineer, has submitted to the Corporation an estimate of the cost of laying and equipping the electric tramways authorised by the order obtained last year. Exclusive of the generating station and plant, the estimate amounts to over £50,000.

Birkenhead.—The B. of T. has approved of the construction of two passing places on the New Ferry route of the Birkenhead tramways. The borough engineer and surveyor has reported upon a proposed double track in Park Road North, and also as to the desirability of laying double tracks in all positions where the width of the streets will admit of this being done. The engineer has been requested to furnish the Committee with a detailed estimate of the cost of the proposed work.

Blackburn.—The conversion of the Cemetery and Accrington Road sections from steam to electricity on the overhead trolley system is gradually approaching completion. The Corporation have decided upon another important extension of the trams to the Audley district. The report of Mr. Giles, the electrical engineer, shows that there is little prospect of this section being worked at a profit, but the public mandate is overwhelming, and the work is to go on. The preparation of estimates for the continuation of the Billinge End section along Revedge to Four Lanes end has also been ordered. Landowners have offered certain facilities for widening the road, and the work, if carried out, will be an important advance in the general scheme for running a circle of trams round the north, west and easterly parts of the borough.

Blackpool.—At the T.C. meeting on 2nd inst. it was stated that the receipts from trams for last year were £30,658, as against £22,590 in the previous year, an increase of £8,068, but £3,000 behind the estimate, owing to the wet weather in August. After paying interest on capital and sinking fund, £8,000 or £9,000 can be handed over to the relief of rates.

Blackpool and Garstang.—At the Board of Trade on 2nd inst. Sir Courtenay Boyle heard the objections of the Blackpool Corporation and the Cyclists' Touring Club to a light electric railway order from Blackpool to Garstang, a distance of 11 miles.

Dover.—The Corporation electric tramway receipts for the year ending March 31st were over £10,776, an increase of £713 on the previous year, when the profits were about £2,000.

East Molesey.—The U.D.C., by the casting vote of the chairman, has decided not to consent to the local scheme of the L.U.T., unless the company provide the statutory road width for a double line.

Gateshead.—At last week's City Council meeting, with reference to the tramways and the electric wire dangers, the Parliamentary Committee reported that the protective device intended to be adopted by the company was the ordinary one. The Committee thought greater safety was required, and they suggested a consultation with an electrical expert. The report was adopted.

Glasgow.—The Board of Trade inspection of Crosshill to Overnewton and Whiteinch to Dalmarnock sections by Colonel Yorke, R.E., and Mr. Trotter took place on April 2nd. Bailie Paton, the convener, and several councillors and the tramway staff accompanied the party. Some 300 invitations have been issued for the inauguration of the new service on the 25th inst. Much amusement has been caused in local engineering circles at the rivalry shown by the workmen of Messrs. Allis & Co., America, and Messrs. Musgrave, of Bolton, in their endeavours to be first to get their engines running. The Americans look like winning, as they were to have steam on by the 6th inst. Of course, this only applies to the 5,000-H.P. engines, two of which each firm is supplying. The two 1,000-H.P. engines by Messrs. D. Stewart & Co., Glasgow, have been ready to start for the last six weeks.

Heston—Isleworth.—The U.D.C. have interviewed Mr. J. Clifton Robinson, managing director of the L.U.T., as to the application made by their clerk for costs, as a result of which, Mr. Robinson has promised not to withdraw the local portion of his Tramway Bill in Parliament, and has also expressed a readiness to meet the Council in the matter of street widenings.

Ilkeston.—The T.C. has resolved that the first section of the tramlines shall be laid, also electric mains for lighting purposes; and further, that the borough engineer shall be instructed to prepare the necessary plans and specifications for the above-named works immediately.

Kingston-on-Thames.—At a special meeting of the T.C. on Tuesday, Councillor Lyne announced, as chairman of the Tramways Committee, that an agreement had at length been come to with the London United Tramways, Limited, the following being the principal heads of the draft agreement which was approved:—

(1) The retention of the purchase clause at a term of 25 years. (2) A modification of the company's scheme to suit the local thoroughfares in the provision of single lines where the Corporation's original scheme provided them, or double lines and street widenings at the option of company. (3) Specified widenings in principal streets at an estimated cost of £25,000, as against £10,000 originally offered by the company. (4) A contribution to certain footpath improvements at the option of the Corporation. (5) A wayleave at the rate of £225 for the first five years; £450 for the next 10 years, and £700 thereafter, this being a little less than the original offer. (6) Similar conditions with regard to extensions at the option of the Corporation, or under the arbitration of the Board of Trade. (7) Penny route fares within the borough, but a guaranteed 10 minutes through 1d. service to Surbiton from three points. No through transfer tickets. (8) Statutory workmen's ½d. fares.

Leeds.—Last week Major Pringle, of the Board of Trade, went over the Beeston, Elland, Meanwood and Woodhouse street tram routes for the purpose of fixing stopping places and speed on gradients.

Light Railways.—The object of Mr. G. Balfour's Bill referred to last week is to continue the powers of the Commissioners for five years, pay a salary not exceeding £1,000 a year to a second commissioner, who is to be a barrister of not less than seven years standing, and it is proposed that of the £1,000,000 authorised to be advanced, £750,000 should be available for special advances, and £250,000 for other advances.

Lincoln.—The Electricity Works Sub-Committee has resolved that Mr. A. Brown, city surveyor of Nottingham, should be requested to advise and confer with the Committee on several matters in connection with the undertaking of the Lincoln Tramways Company, Limited. Alderman Harrison moved the adoption of the minutes, and said the Committee was now paying its way. It was not only paying current expenses, but sinking fund and interest as well. Mr. Brown would advise the Corporation as to the cost of the taking over of the present tramways and what a fair price would be.

Liverpool.—With a view to relieving certain of the main tramway routes near the centre of the city, in the event of any exceptionally heavy traffic, and also to provide alternative routes for use in case of temporary stoppages of traffic from any cause on the main lines, tramways have been laid in North John Street, Victoria Street, Crosshall Street, and Hood Street, Liverpool. The track work in these streets has been completed. The overhead wiring has yet to be fixed.

Manchester.—The question of the supply of electricity for the new car service from Cheetham Hill to the city was incidentally mentioned at the meeting of the City Council last week. Mr. Wilson asked whether it was true that the Electricity Committee would not be prepared this month to supply power for opening the electric car service on the route from Albert Square, &c. Dr. Bishop replied that he was bound to say that there would be a delay of several weeks. The several weeks' delay would date from the 22nd inst., which was the day fixed for opening the service.

Metropolitan Railway and Electric Traction.—The *Engineer* says that "Some wonder has been expressed that progress is not being made in adopting electricity as a means of propulsion on the Metropolitan Railway. Within the last few days sensational statements have been made to the effect that the line had been bought for the United States by a Mr. Yerkes. These statements must be taken for what they are worth, which is not much. We believe that the fact is, that about £1,000,000 worth of stock is held by an American, who has so far the power of control, and has used it to block all progress. The position, both from an engineering and a financial point of view, is very curious, and we fancy without a precedent."

The *Scientific American*, under the impression that the Ganz system has been actually adopted, tries to drive home to American electrical railway men the necessity that exists for greater vigilance in the following terms:—

There is food for thought in the fact that the directors of the Metropolitan and District Underground Railways have decided to use the Ganz high-voltage, tri-phase system in the electric equipment which is to be carried out on these two important roads . . . . It is stated that the choice of the directors was based upon the fact that the Ganz bid was $1,000,000 cheaper than the lowest American tender, and that the operating expenses were represented to be 30 per cent. lower than those of the low-voltage, direct-current system as used in this country. American practice is to generate high-tension alternating current for transmission, and transform it at sub-stations to low-tension direct-current for use at the motors, the usual potential being about 500 volts. In the Ganz system, as used in the new Italian road, three-phase current of 20,000 volts potential is supplied to the line, and is transformed at sub-stations to 3,000 volts, at which high pressure it is used directly at the motors. The Hungarian engineers have succeeded in overcoming the difficulties of insulation which are attendant upon the use of such high pressure, and have apparently gained all the resulting economies of construction and operation. It can justly be claimed that America is the birthplace and the home of successful electric traction. We have hitherto led the world both in the improvement and development of this system of transportation, and to many people it will come as something of a shock that a European firm should apparently have moved ahead of us in the improvement of the art. If the contract should be secured by the Buda-Pesth firm it will be but another illustration of the fact that, however supreme a nation may be in any particular industry, it can never afford to rest upon its laurels. It must be prepared to meet an ever-extending competition, as other nations begin to centre their intelligence and skill upon the improvement of existing systems and plants.

Newcastle-on-Tyne.—On 13th inst. the horse tramways lease expires, and the Council has refused to renew it, in order that the contractors may make progress with the preparation of the electric tram tracks. Out of the 21 miles of line required, 13 miles has been laid, and it is expected that the cars will be running in September.

Plymouth.—The Compton section of the electric tramways was inaugurated on April 3rd.

St. Helens.—The Electric Supply and Tramways Committee have acceded to a request made by representatives of the St. Helens Tramways Company and the South Lancashire Tramways Company, that permission should be given for the carriage of goods over the St. Helens system during the daytime. The permission was granted subject to suitable terms of carriage being arranged, and the town clerk was instructed to negotiate with the company respecting terms.

The new lifeguard with which the St. Helens tramcars are provided, passed satisfactorily through a crucial test on Sunday last. The machine of a cyclist named Eckersley skidded when crossing the tramlines, and rider and machine fell in front of an advancing car. The driver, George Houchen, immediately dropped the lifeguard, which caught up Eckersley and his machine, and carried them both until the car stopped. Neither machine nor rider was injured.

St. Petersburg and Moscow.—The strong movement which has come about in favour of electric railways in Germany has (says our contemporary the *Engineer*) made itself felt in Russia, although there is not at this moment such a pressing need of quicker means of communication between the provincial towns of the latter country. Still, under certain circumstances, Russia may develop such a need. During the summer of 1900, M. Romanoff constructed at Gatschina, 20 miles from St. Petersburg, a small electric railway on a system which he had invented, and the results were thoroughly satisfactory. M. Romanoff now desires to apply his system to a railway on a much larger scale, and he has drawn up a project for constructing an electric railway from St. Petersburg to Moscow. It has long been well known that the existing Nicolas Railway, connecting the old and new capitals of Russia and 404 miles in length, is unable to cope with the traffic. The authorities entertain the idea of separating the passenger traffic from the goods traffic, and for this purpose it is said that two other tracks are to be laid down. However, M. Romanoff has now come forward with a proposal to construct an electrical "hanging railway," which shall take the place of increasing the carrying capacity of the present line by the addition of two tracks. The cost of this suggested railway would amount to 98,000,000 roubles, and the yearly cost of its working would represent 12,819,000 roubles, of which sum 80 per cent. is absorbed by the cost of fuel. M. Romanoff computes that the cost of passenger traffic will come to about half a kopeck, or ¼d. per verst of two-thirds of a mile. The rate of speed to be attained on the "hanging railway" is estimated to be 120 kiloms. an hour, with a limit of 200 kiloms., as occasion shall demand. This is the normal rate of speed of the electric railways of the future, according to the views held by experts. The project thus put forward by M. Romanoff has aroused a great deal of interest in St. Petersburg, and it would undoubtedly increase its claims upon the attention of the publi if it could be shown that it would be constructed with more regard for the interests of the region through which it will pass than was the case when the present railway between St. Petersburg and Moscow was built. It ought not to be a difficult matter for the projected railway to take in its route a few of the towns which the Nicolas Railway left cut off from communication by rail with the outer world.

Stalybridge.—A hitch has, according to the *Manchester Courier*, arisen in connection with the suggested scheme of electric traction and lighting in which the Corporations of Stalybridge, Mossley, Dukinfield and Hyde have agreed to be partners. A Bill has been presented to Parliament for sanction to a scheme, which includes the Flatts site at Stalybridge as the one most suitable for the erection of a generating station. The joint electricity board, however, recently changed their minds on the subject, and by a majority of 15 to 5 decided to petition Parliament to amend the Bill and include another site at Dukinfield in place of the one at Stalybridge. The Stalybridge representatives are unanimously against this proposition. At the meeting of the Stalybridge Council the matter was discussed at considerable length. The General Purposes Committee had previously passed a resolution declining to recommend the Council to seal any petition to Parliament to substitute another site for the Stalybridge one until a competent person had inspected and reported as to which of the two sites was most suitable. The Committee also suggested that Parliamentary agents should be asked to apply to the Board of Trade to nominate an engineer or inspector to decide the question. The minutes were adopted.

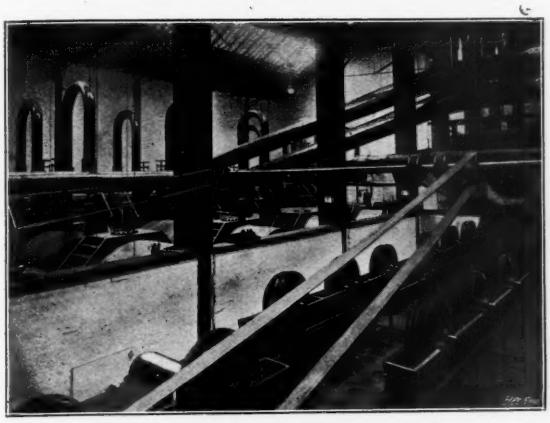
Sweden.—A scheme for the construction of a network of electric tramways in the town of Gothenburg, at an estimated cost of 2,990,000 krona, is at present under consideration.

West Bromwich.—The T.C. has granted a further period of three months for the use of steam on the South Staffordshire tramways to the South Staffordshire Tramways (Lessee) Company. The company wanted a 12 months' extension, but the Council does not want the introduction of electric traction delayed so long.

(*Continued on page* 635)

MANCHESTER ELECTRIC POWER STATIONS.

From time to time we have placed before our readers particulars and photographs illustrating the development of



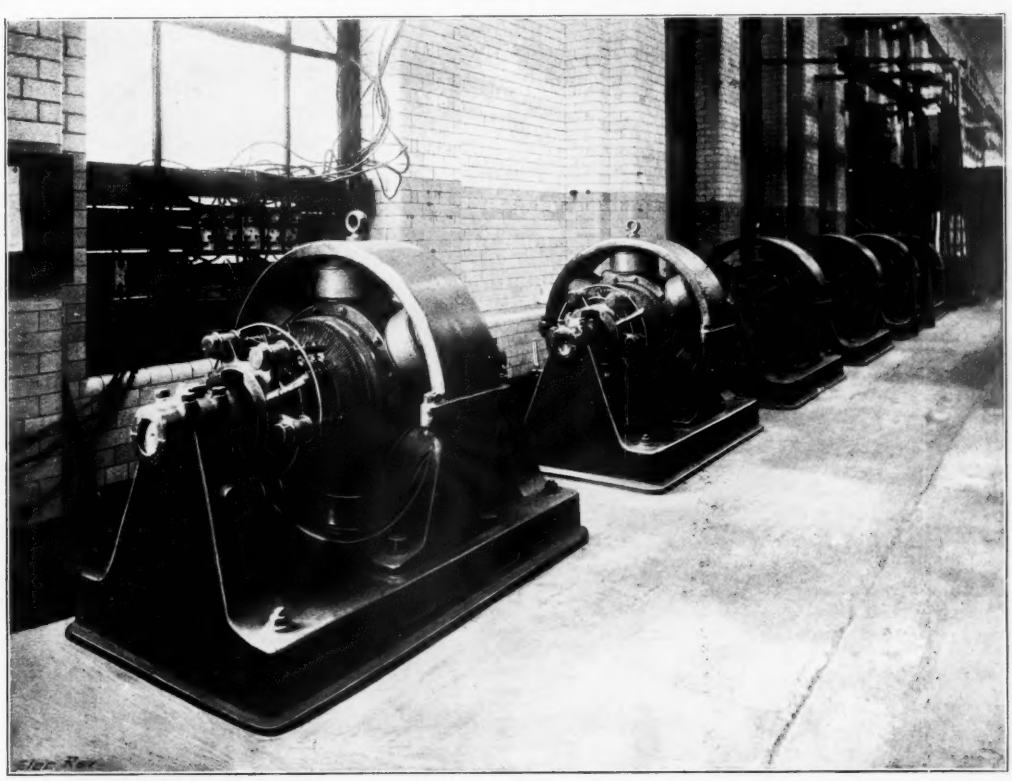
New Boiler-House at Dickinson Street.

the electricity supply undertaking of the Corporation of Manchester, of which—more especially of recent years—the scope has constantly increased. The Corporation has undertaken to supply, in addition to its own city area, which consists of some 20 square miles, a number of adjoining districts, making in all an area of about 45 square miles. The supply to be given comprises not only lighting and power, but also the energy for electric traction purposes.

The scheme which has been worked out by Mr. C. H. Wordingham for supplying this large area is as follows :—

The supply to consumers throughout the whole area is to consist as heretofore of continuous current, distributed from a five-wire network in the central part of the city, and from a three-wire network in the remainder of the area, with a pressure of 400 volts across the outers in each case. The tramway network is to be supplied at a pressure of 500 volts. Each network is to be so arranged that it may be either connected up throughout or split up into a number of small portions.

Both networks are to be fed partly by current generated at low pressure and partly by current generated at extra high pressure, the arrangement being as follows :—The present generating station at Dickinson Street, in which current is generated at 440 volts or thereabouts, is to be retained, and will be supplemented by an additional generating station at Bloom Street, adjoining Dickinson Street. The capacity of the Dickinson Street station is 12,000 I.H.P., and that of the Bloom Street station is to be 14,000 I.H.P. These two stations together will eventually supply the whole demand within a radius of half a mile, which includes the bulk of the lighting demand and by far the densest portion of the tramways. The remainder of the network will be supplied from a single generating station at Stuart Street, on the eastern border of the city, which is intended to have an eventual capacity of 50,000 H.P. Here three-phase current will be generated at a pressure of 6,500 volts, and will be transmitted to sub-stations pitched about a mile apart. In each of these sub-stations the current will be transformed down to a suitable pressure, converted by means of rotary converters to continuous current, and fed into the distributing network. The step-down transformers will be provided with secondary windings so arranged as to give two distinct pressures, the lower pressure being such as to give 420 volts or thereabouts for the lighting network, while the higher



Rotary Converters at Dickinson Street.

will give about 500 volts for the tramways, on the direct current side of the converters.

Each sub-station is designed to supply an area having a radius of about half a mile.

The use of different pressures for lighting and traction was practically unavoidable, since it was imperative to have uniformity throughout the whole area for lighting consumers, and it would have been out of the question to alter the pressure from 400 to 500 volts when so large an amount of plant was already installed for the lower pressure, the consumers numbering some 3,700, with lamps and apparatus equivalent to 382,000 8-c.p. lamps. On the other hand, it was equally imperative that the traction network should be supplied at the pressure which has become standard in this country, not only because the standard pressure rendered stock equipments available, but also because in the future it is practically certain that traffic will be interchanged between various large towns, and the inconvenience of a difference in pressure would have been very great.

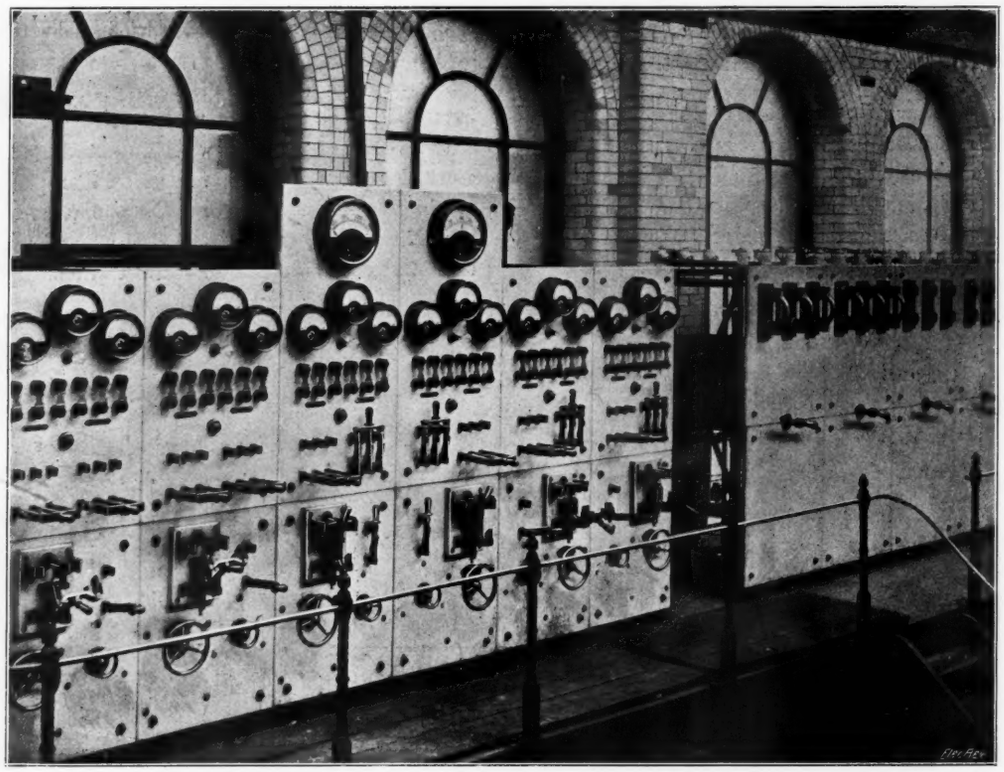
In drawing up this scheme, Mr. Wordingham was very largely influenced by considerations relating to possible difficulties in connection with electrolysis on the tramway system, and his principal object in spacing the sub-stations at so short a distance apart has been to keep down the loss of pressure in the rails to a very low figure. It is hoped that in most cases the maximum drop will not exceed 1 or $1\frac{1}{2}$ volts.

As regards the present state of the scheme, Dickinson Street is fully equipped, and Bloom Street station is now under construction, while though the general scheme for Stuart Street has been worked out, the specifications have not yet been drawn up, nor any of the contracts let. Much work, however, has been done in connection with acquiring sites for sub-stations, and laying the extra high-pressure mains and the low pressure networks.

In order to test the main scheme, and at the same time to enable certain distant portions of the district to be supplied before the final arrangements were completed, some temporary three-phase plant was ordered some time ago, and has just been put to work.

This plant is arranged as follows:—Continuous current generated at Dickinson Street, at a pressure of 420 to 440 volts, is passed through six rotary converters, each having a capacity of 100 kw., and is by them transformed into three-phase current at a pressure of about 260 volts. The direct current sides of all these rotaries are supplied in parallel, and the three-phase sides also deliver in parallel to three omnibus bars, from which the primary windings of transformers are supplied. There are six sets of these, each set consisting of three single-phase transformers, having their windings connected star fashion.

The transformers raise the pressure to 5,000 volts, at which the three-phase current is transmitted to two sub-stations; a separate main runs from Dickinson Street to each of these sub-stations, and a cross-connecting main runs between them so as to give an alternative supply to either sub-station through the other. These mains will be referred to later on. At each sub-station the three-phase current is taken to high pressure omnibus bars, and thence through the primary windings of two sets of transformers. As at Dickinson Street, each set comprises three single-phase transformers, but the low-pressure winding has attachments made at ten different points, thus giving ten different pressures at will. From the low-pressure side of the transformers the current is passed into the slip rings of two 100-kw. rotary converters, the direct current sides of which supply the distributing network. The high-pressure windings of all the transformers are connected star fashion.

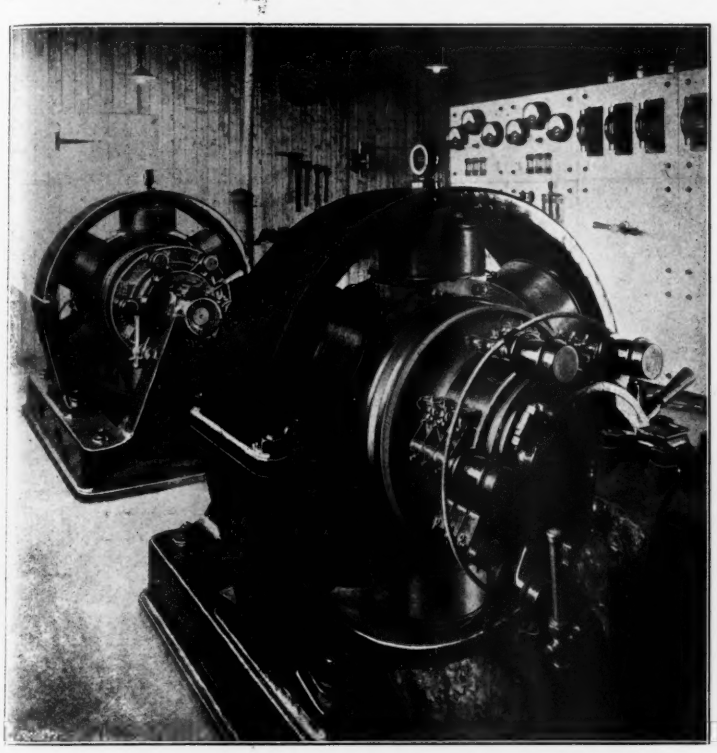


Three-Phase Switchboard at Dickinson Street.

The switchboard arrangements are such that every rotary converter is controlled by an automatic cut-out; fuses are arranged throughout the system on both D.C. and A.C. sides, and stock apparatus is employed as far as possible. The high-pressure switches are insulated wholly with porcelain, and give two breaks on each phase. The whole of the high-pressure connections are made with bare copper on porcelain insulators, without oil, and at Dickinson Street they are completely enclosed by wire guards, the switchboard being fixed above the transformers. Especial care has been taken to thoroughly earth every part of the framework and guards, as well as the handles of the high-pressure switches.

The rotary converters are started up from the D.C. side in all cases, and means are provided for varying the field excitation if desired.

The arrangement has been at work for about a month, with results satisfactory in every way, no hitch or difficulty of any kind having occurred. It is noteworthy that one of the sub-stations is supplying a load in which motive power largely preponderates, there being large engineering works taking some 350 H.P. close by. Before the sub-station was got to work this portion of the network was supplied at low pressure from Dickinson Street, with the result that the pressure in place of being about 406 volts was only from 320 to 330 volts. It is interesting to note that the sub-stations are supplying in parallel with the low-pressure generating station, the network forming one continuous whole.



100 KW. ROTARY CONVERTERS AT MOSS-SIDE SUB-STATION.

It should be emphasised that the above arrangement is only a temporary one, as of course it would never be contemplated to permanently use a four-fold transformation such as that described. It is intended to generate the current in the permanent scheme directly at 6,500 volts.

The efficiency of the system is most satisfactory. Mr. Wordingham specified that the plant should be run at the makers' works connected in such a manner that continuous current was taken in by a rotary converter, converted to low pressure three-phase current, stepped up by a transformer, stepped down again, passed through a second rotary, and the continuous current from this absorbed by an artificial resistance. In this manner measurements of continuous current only had to be made.

When run under these conditions, after six hours the mean of the efficiencies at full load, three-quarter load, and half-load was specified to be not less than 78 per cent. The actual tests of a combination run in this way gave an efficiency of 79·7 per cent.

Other combinations were tested by a modification of the Hopkinson method, the continuous current being returned to the first rotary, and the efficiencies of the combination measured in this manner varied from 78 per cent. to 80 per cent. Full particulars are given in the annexed table :—

TESTS OF FOUR-FOLD CONVERSION PLANT.

	First set. Per cent.	Second set. Per cent.	Third set. Per cent.	Fourth set. Per cent.	Fifth set. Per cent.	Sixth set. Per cent.	Required by specification.
Full load ...	81·1	79·2	80·9	80·7	80·3	80·6	—
¾ load ...	80·3	80·6	80·8	80·0	78·9	80·6	78
½ load ...	77·6	80·0	78·3	78·0	75·3	79·0	74
Mean efficiency	79·7	79·9	80·0	79·2	78·0	80·0	78

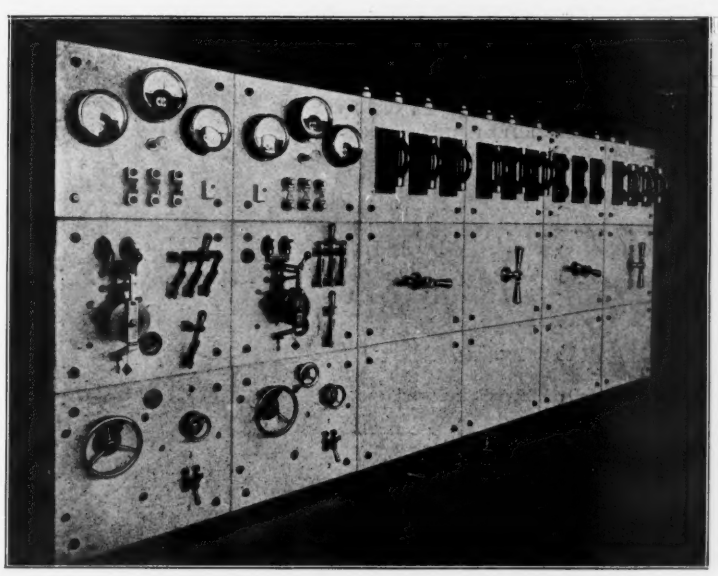
The method of balancing the continuous current three-wire network is one that does not appear to be generally known in this country, and as it is extremely successful and satisfactory it may be worth describing.

As already stated, the windings of the transformers are connected star fashion. A connection is taken from the middle wire of the ordinary three-wire network to the middle point of the low-pressure winding of the step-down transformers, and the rotary supplies current directly to the outer conductors of the network. The whole of the balancing is done on the alternating side of the combination. Experiments show that the results obtained are quite as good as with the ordinary methods by means of balancing motor generators, if not better, and the elimination of this apparatus is a material gain in every way.

It may be mentioned that the middle point of the star on the *high* pressure side of the Dickinson Street station is connected to earth.

The whole of the transforming plant, together with the switchboards, was supplied and erected by Messrs. Thomas Richardson and Sons, West Hartlepool, the English representatives of Messrs. Brown, Boveri and Co. ; Mr. Oswald Dewey, distributing station assistant, was responsible to Mr. Wordingham for supervising the contractors during erection, and for carrying out the efficiency tests.

A short description of the three-phase feeder system may now be given. The map on page 634 shows the general scheme of the district. The sub-stations are situated at the centres of the circles, which are half a mile in radius, those intended for supplying Manchester and the adjoining districts of Moss Side, Withington, Heaton Norris and Levenshulme being shown. Additional sub-stations will, of course, be required for other districts, the orders of which have been taken over, viz., Denton, Audenshaw, Droylsden, Prestwich, Failsworth, Whitefield, &c.



SWITCHBOARD AT MOSS-SIDE SUB-STATION.

Section of Cable.

The lines show the routes of the high pressure three-phase mains serving to connect the sub-stations with the generating station at Stuart Street, the figures placed against the lines indicating the number of cables along each portion of the route. It will be observed that the number of separate cables is very large, as many as 30 leaving the Stuart Street generating station. This is owing to the requirements of the Board of Trade, who could not be persuaded to allow mains to be used, having a larger capacity than 1,000 kw. each.

The general scheme of the arrangement of the mains is such that there shall be a direct main from the generating station to each sub-station, and an alternative means of reaching each sub-station.

All the feeders are of uniform size, each comprising three conductors 0·15 square inch section; the conductors are stranded and made into the shape of a sector of a circle with rounded corners, thus enabling the conductors to lie more compactly together in the cable.

The three conductors are laid up to form what is sometimes called a clover leaf cable; the insulation employed is impregnated paper, the impregnating material being practically free from moisture. The insulation is enclosed within lead in the usual way, and over the lead is an armouring of round steel wires. A section of the cable is shown in one of our figures.

The cables were supplied by the British Insulated Wire Company, Limited, of Prescot, and were laid by the Corporation's own staff.

(To be concluded.)

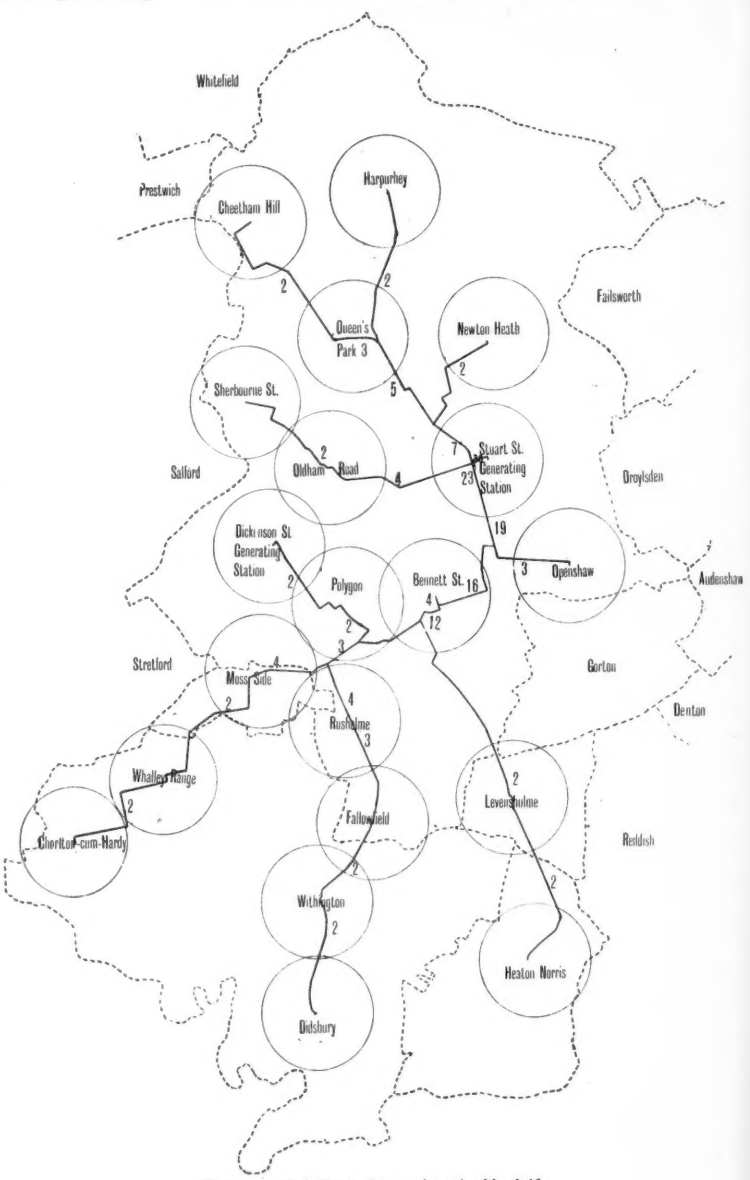
LONDON COUNTY COUNCIL TRAMWAYS.

In the April number of *Fielden's Magazine* there is a short editorial on the Kennedy conduit. This article confirms our previous criticism upon the small amount of practical knowledge shown by most of the writers upon the subject. The article in question caps the climax for absurdity.

For instance, the writer says: "The Kennedy conduit differs radically from the commonly accepted type in that, as should be evident to any engineer familiar with electric tramway work, it has been designed to meet entirely different conditions." The slur upon the intelligence of even "any engineer" would have been more effective if these "entirely different conditions" had been mentioned. Most engineers familiar with the subject had supposed that if the conditions in London differed from those in other cities, it was only that they were more severe, and that, therefore, extra precautions would be necessary to ensure success. Apparently, in the opinion of the writer of the article, this is not so.

He defends the light weak yokes of the Kennedy conduit for the reason that they were designed for the "good solid roads" of London. That the up-town conduits in New York were blasted out of solid rock seems to have escaped the knowledge of the writer. If these are not solid roads we should like a definition of the expression.

It is true that there is no necessity whatever for carrying the track rails upon extensions of the yokes; but it does not follow that strong yokes are uncalled for. On the contrary, we venture the assertion that if there is a city in the world where strong unyielding yokes are needed it is this city of London. We are informed by experienced engineers that if the Kennedy conduit should be subjected to the strains due to frost, it would be impossible to insert the blade of a penknife in the slot.



The numerals indicate the number of cables laid.

Map of Feeder System (Manchester).

We will refer to one other statement in this article. The writer states that the carrying of the insulators by the yokes is an "additional burden" to these, and will involve a heavier form of yoke. A yoke has to support the greatest loads that can be put on it by the street traffic. It must at least support the heaviest load carried on one wheel of a wagon. If the paving were even slightly below the level of the slot rail this load would be in the form of impact, and the yoke would have to stand the shock of such. The conductor rail weighs approximately 25 lbs. per yard, and with a yoke spacing of 5 ft. each yoke would have to support the "additional burden" of, say, 100 lbs. We should like to see the calculation showing the extra amount of iron used in the yoke for this "additional burden."

Really, if "militantly British" magazines publish such leaders as this on the subject, they may lay themselves open to the ridicule of American and Continental engineers, who have at least an elementary knowledge of the subject.

ELECTRIC TRACTION NOTES.

(*Continued from page* 630.)

West London.—It is stated that all the difficulties between the London United Tramways Company and the Royal Observatory at Kew were satisfactorily adjusted on 3rd inst. The lines have now been formally opened for public traffic, and great business is doing. Our congratulations to Mr. Clifton Robinson and his board.

Wigan.—At the meeting of the T.C. last week, Councillor Worthington, chairman of the Electric Lighting and Tramways Committee, reported that the work on the Wigan Lane line was progressing favourably, and if the weather permitted they anticipated opening the line next month. The work at the power station was also well advanced.

TELEGRAPH AND TELEPHONE NOTES.

Belfast Telephones.—At the meeting of the Joint Law and Improvement Committee, the town clerk reported that he had received from the Postmaster-General the engrossment of the license to authorise the Corporation to establish a municipal telephone system in the city.

Dundee Telephones.—The T.C. is to consider the question of telephone municipalisation, and to appoint a committee to report.

Glasgow Telephones.—The first 100 subscribers were switched on to the Corporation system for the first time on April 2nd. The system adopted is that of underground paper insulated cables, the wires being "bunched" and lead-covered. All the underground work has been made air-tight and water-tight. The total borrowing powers of the department amount to £121,000, but of this only some £25,000 has as yet been spent in cables and street mains. The switch-room or exchange is in a central position, and measures 8,000 square feet. Branch exchanges are to be placed in Bridgeton, Hillhead, Maryhill, Springburn, Kinning Park, Govan and Crosshill. The total area to be supplied extends to some 143 square miles, and in addition trunk lines are to be laid to Kirkintillock, Kilsyth, Clydebank, Busby, and Ruthoglin. The total accommodation is sufficient for at least 12,000 subscribers, of which 4,800 have already become subscribers. Of this latter number some 2,000 are already on the National Company's service. The charge for unlimited use is £5, and for a toll service £3 10s. per annum, plus one penny per call. The first section of the main switchboard, for 1,000 subscribers, has been completed, and the second section is now under way. The department is under the control of Mr. A. R. Bennett, by whom the installation is being carried out.

Manchester Telephones.—The Town Clerk of Eccles recently reported that conferences had been held of representatives of local authorities in the Manchester telephones area, and that the following scheme had been approved:—"A joint board to be formed consisting of representatives appointed annually by the municipal and urban district councils within the area, as follows, viz.: Manchester Corporation ten members, Salford Corporation five members, Eccles Corporation and the Urban District Councils acting jointly three members. The capital to be provided by the Manchester and Salford Corporations. Profits not exceeding 5 per cent. on the capital expenditure (less *bonâ fide* renewals) to be divided between the Manchester and Salford Corporations proportionately to the capital provided by each. All profits above 5 per cent. to go in reduction of telephone charges. The respective councils to grant underground wayleaves without payment. No differential charges for telephones."

The Telegraph Wire Export Trade.—According to the returns just issued, the value of the telegraph wire and apparatus connected therewith exported from this country during March last attained a value of only £106,638, as compared with £126,510 in the preceding month, and £201,940 in March, 1900. Notwithstanding the small total for the past month, the figures for the first quarter of the year show a satisfactory increase, the exports during the period named having amounted to £829,270, as against £758,819 in the corresponding quarter of last year, and only £392,760 in the first three months of 1899.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Taku-Chefao	March 29, 1901 ..	..
Conakry-Sierra Leone	April 2, 1901 ..	..
Bonny-Kamerun	April 4, 1901 ..	April 7.
Marseilles-Barcelona	Jan. 7, 1901 ..	April 9.
Landlines :—		
St. Louis (Senegal)-Bathurst	August 25, 1901 ..	March 29.
Siberian landlines—		
Blagowestchensk-Chabarowsk	April 3, 1901 ..	..

Trunk Line Telephonic Communication.—In the House of Commons on 2nd inst., Sir Harry Bullard asked the Secretary to the Treasury, as representing the Postmaster-General, whether he was aware that at the present time there were delays in telephoning to Norwich and the Eastern Counties, and whether he would consider the question of giving increased trunk line communication to those places. Mr. A. Chamberlain replied: New direct lines from Norwich, Ipswich, and Cambridge to London, and between Norwich and Yarmouth, were brought into use in the latter part of last year, and there is no considerable delay at present in messages to and from the Eastern Counties under normal circumstances, though there have been frequent interruptions owing to the storms during the last three months. The Postmaster-General has under consideration the provision of additional direct lines from London to Ware, Chelmsford, Cambridge, and Norwich, with a view to the improvement of communication not only with those places, but also with other places with which they are in communication.

Tunbridge Wells Telephones.—A pamphlet issued by the Tunbridge Wells Corporation states that they have undertaken to pay the whole of the terminal charges, so that the subscribers to the municipal system will have an advantage over those of the National Telephone Company, in that the former will not have to pay any terminal charges; while the latter, desiring to communicate with anyone on the municipal system, will have to pay terminal charges. The trunk line charges are the charges for the use of the Post Office trunk wires, and are payable by subscribers to both systems. The town clerk of Tunbridge Wells, in calling attention to the pamphlet, adds:—"The subscribers to our municipal system are entitled to speak to every subscriber on the National in any part of the kingdom on payment of trunk-wire charges only. I may also mention that subscribers to municipal systems will be able to communicate with one another free of terminal charges, while subscribers to the National will have to pay them."

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—April 27th. The E.L. Committee wants tenders for six water-tube boilers and accessories. See "Official Notices" to-day.

Alloa.—April 25th. The E.L. Committee wants tenders for insulated cables, joint boxes, &c.; arc lamps and pillars; sub-station equipment and sundry connections. See "Official Notices" to-day.

Aylesbury.—April 22nd. The U.D.C. wants tenders for establishing and maintaining electricity works. See "Official Notices" March 22nd.

Barrow-in-Furness.—April 24th. The Corporation wants tenders for concentric cables, boxes, cast-iron pipes, conduits and pipes, balancing transformer and switchboards. See "Official Notices" April 5th.

Battersea.—April 30th. The Council wants tenders for electric pumps and pipe work, river work, pipe and pits, &c. See "Official Notices" March 29th.

Battersea.—The Borough Council invites firms to submit free wiring proposals. See "Official Notices" to-day.

Cardiff.—April 30th. The Corporation wants tenders for poles, bases, brackets, feeder and section pillars, trolley and other wire, insulators and line suspensions, for electric tramways. See "Official Notices" to-day.

Colwyn Bay.—April 13th.—The U. D. C. wants tenders for water-tube boiler, feed pump, injector, piping, &c. See "Official Notices" March 29th.

Copenhagen. — May 4th. The Corporation wants tenders for the supply of a network for a new central station. See "Official Notices" to-day.

Dublin.—April 22nd. The Lighting Committee wants tenders for condensing plant, pipework, feed pump, superheaters, mechanical coaling apparatus, crane, and workshop equipment. See "Official Notices" March 22nd.

Edinburgh.—April 20th. Tenders are wanted by the Corporation for arc lamp carbons and cast-iron pipes. See "Official Notices" March 29th.

Egypt.—April 15th. The Ministry of Public Works, Cairo, will on April 15th consider tenders for the installation of electric light in the town of Zagazig.

France.—April 18th. Tenders are being invited until April 18th by the French Ministry of Posts and Telegraphs, for the supply of 270 tons of copper or bronze wire. Tenders to be sent to Le Sous-Secretarial d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris, whence particulars may be obtained.

Germany.—May 1st. The Prussian State Railway Authorities at Munster are inviting tenders until May 1st for the supply of a steam engine and dynamo. Particulars can be obtained from, and tenders are to be sent to, Die General Direction der Könèg, Eisenbabnen, Munster.

Kirkcaldy.—April 15th. The Corporation wants tenders for two 80-I.H.P. and three 250-I.H.P. engines and continuous current dynamos, storage battery, and 15-ton crane. See "Official Notices" March 15th.

Leeds.—April 15th. The City Council wants tenders for steam and other piping, pumps, economisers, &c., all for engines of 4,000 I.H.P. See "Official Notices" March 15th.

London.—April 24th. The Metropolitan Asylums Board invites tenders for gas producing plant and gas engines, dynamos, accumulators, and switchboard; Galloway boilers, economiser, feed pumps, &c., for Tooting Bec Asylum. See "Official Notices" March 22nd.

Madrid.—April 21st. The Secretary of State for Foreign Affairs has received a despatch from his Majesty's Ambassador in Madrid, stating that tenders are invited by the Spanish Government, not later than April 21st, for the establishment and working of a telephone system in Palencia. Particulars may be examined at the Commercial Department of the Foreign Office, between 11 a.m and 5 p.m.

Manchester.—May 7th. The Electricity Committee wants tenders for water-tube boilers; plant of 15,000 I.H.P. in generating and sub-stations, comprising steam engines, &c., three-phase generators and motor transformers. See "Official Notices" to-day.

Middlesbrough.—April 30th. The E.L. Committee wants tenders for a Lancashire boiler, 300-KW. steam dynamo, condensing plant, and piping. See "Official Notices" March 29th.

We would draw tenderers' special attention to the latest date for sending in estimates. It is April 30th and not 13th, as appeared in our "Official Notices."

Motherwell.—April 29th. The T.C. wants tenders for steam dynamo and switches and piping. See "Official Notices" March 29th.

Norwich.—May 7th. The Norwich Mutual Telephone Company, Limited, is about to establish a telephone exchange, and invites tenders for cables, wires, pipes, ironwork, poles, insulators, batteries, telephones and other instruments, switchboards, &c., required in connection therewith. See "Official Notices" to-day.

Piatra Neamtz, Roumania.—April 23rd (new style). The mayor will on this date consider offers for the concession of supplying the town with electric light for a term of 30 years.

Plymouth.—April 4th. The Plymouth, Stonehouse and Devonport Tramways Company is inviting tenders for the reconstruction of the existing tramway lines in Plymouth, Stonehouse and Devonport, and the reduction of the gauge from 4 ft. 8½ in. to 3 ft. 6 in., and the bonding of the rails for electric traction. The rails, points, crossings, tie bars, fish-plates, fish bolts, copper bonds, and any granite setts required will be supplied by the Tramways Company. Conditions of contract, &c, can be obtained on application to Mr. John Glenn, C.E., engineer, 11, Queen Victoria Street, London, E.C., on payment of £3 3s.

Portsmouth.—April 30th. The Corporation wants tenders for various works in connection with the establishment of the municipal telephone system:—conduits and cables, copper and other wire, ironwork, insulators, switchboards, batteries, telephone instruments, poles, arms, &c. See "Official Notices" to-day.

Poplar.—May 1st. The Guardians want tenders for steam, exhaust, and other piping, valves, &c. See "Official Notices" April 5th.

Partick.—The Council wants tenders for main switchboards and instruments, battery and accessories. See "Official Notices" to-day.

Portsmouth.—April 16th. The Corporation wants tenders for boilers, pumps, stokers, economisers, pipes, &c. See "Official Notices" March 29th.

Southwark.—April 19th. The Council wants tenders for incandescent lamp brackets, switches and fittings, for gas standards. See "Official Notices" April 5th.

Spain.—April 28th. The Secretary of State for Foreign Affairs has received dispatches from Madrid stating that tenders are invited by the Municipality of Lopera (Jaen) for the concession of the exclusive right of lighting the town by electricity; by the Spanish post office, to be received not later than May 10th, for a concession for the establishment and working of a telephone system at Denia; and by the Spanish Government, to be received not later than June 3rd, for a concession for working a system of electric tramways at Barcelona, the concession already granted having been annulled.

Sunderland.—April 26th. The Corporation wants tenders for steam and other piping and panels for traction switchboard. See "Official Notices" to-day.

Tonbridge.—May 30th. The U.D.C. wants tenders for Lancashire boilers, two 50-KW. steam dynamos, condensing plant, crane, switchboard, battery, mains, arc and incandescent lighting, house meters, &c. See "Official Notices" to-day.

CLOSED.

Bristol.—The Electrical Committee report that for the purpose of carrying out the extension of the electrical undertaking authorised on January 1st, 1900, they have entered into the following contracts, viz.:—Pumps, J. and G. Weir, Limited, £415; condensing plant, W. H. Allen, Son & Co., Limited, £3,745; water storage tank, Steavenson & Co., £195; water softening plant, Doulton & Co., Limited, £1,227 15s. 10d.; induced draught plant, Bumsted & Chandler, £1,870; boilers, economisers, &c., Babcock and Wilcox, Limited, £10,476 8s.

Burnley.—A contract amounting to about £16,387 has been given by the Corporation to the Barrow Hematite Steel Company for the supply of the necessary rails for something like seven miles of double track.

Cardiff.—The T.C. has accepted the tender of the Maxim Company for steam pipes for the tramway power station, at £6,858. The lower tenders, it was stated, failed to comply with the specifications.

Derby.—At their last meeting the T.C., on the advice of the E.L. Committee, accepted a tender of Messrs. E. Green & Son for a fuel economiser at £575, and another from Messrs. Babcock and Wilcox, for boiler and purifier, amounting to £1,030, together with one of £600 for steel piping, valves, feed pumps, &c. With reference to Messrs. Green's tender, Mr. A. Otterwell, J.P., said he objected to the way in which it had been received. Their original tender was for £630, and whilst this was under consideration, two other firms were invited to tender, and in the meantime Messrs. Green sent on another for £570. He contended it was not fair to trade upon those lines and accept Messrs. Green's tender after all, especially when it was even then £10 higher than the others. Alderman Heathcote said the Council ought not to countenance such jobbery, and if it was a fact that the secrets of the committee were revealed in order to let any firm have an advantage, the sooner such practices were stopped the better. Councillor Wilkins and Mr. A. Butterworth, J.P., chairman of the committee, explained that Messrs. Green were not informed in any way whatever of the price of the other tenders, and before the others were actually sent in Messrs. Green asked to send in another because a mistake had been made in their previous one in regard to a calculation. Their amended tender was opened at the same time as the others; there was nothing unfair about it and no reason for bringing a charge of jobbery. There was, it was true, a difference of £10, but more than this would be saved annually in the cost of cleaning by an additional advantagetwhich they got with Messrs. Green's economiser, and under the circumstances the committee felt justified in accepting their tender. The explanation was accepted.

Dundee.—The *Contract Journal* states that the contract for the supply of about 1,540 tons of steel girder rails and 60 tons of fishplates for the Town Council has been given out to the Lorain Steel Company. The list of tenders submitted is as follows:—

Lorain Steel Company, Ohio, U.S.A. (accepted) ..	£9,607 14 0
P. and W. Maclellan, Limited, Glasgow	10,167 14 0
Pennsylvania and Maryland Steel Company, U.S.A. ..	10,209 19 0
Dick, Kerr & Co., London	10,247 14 0
Barrow Hematite Steel Company, Barrow-in-Furness	11,587 14 0
Bolckow, Vaughan & Co., Limited, Middlesbrough ..	11,727 14 0
Batchelor & Co., Dundee	11,929 0 0
W. Scott, Limited, Leeds	12,217 14 0
Orenstein & Koppel, London..	12,648 0 0

Glasgow.—A tender for a section of the Corporation main telephone switchboard to control 1,000 subscribers (£3,938) has been accepted, and it is to be made by the Telegraph Manufacturing Company, Helsby.

The tender of Messrs. Bolckow, Vaughan & Co., Middlesbrough, for 2,000 tons of 60 ft. steel rails at £7 10s. per ton, and a quantity of fish plates at £9 10s. per ton, has been accepted, the whole to be delivered in six weeks. Trolley poles for 150 cars at £14 each have been ordered from Messrs. R. W. Blackwell & Co.

The offer, amounting to £5,196, by Messrs. Manlove, Alliot & Co., to supply destructor furnaces, boilers, flues, &c., for Ruchill, has been accepted.

Halifax.—The T.C. has accepted the tender of the Chloride Electrical Storage Syndicate, Limited, Manchester, for supplying a battery of accumulators and regulating switch for £1,340.

Holland.—Tenders were opened on the 1st inst. by the municipal authorities of Amsterdam for the supply and erection of the plant required for the municipal electric power station. The lowest tender was that of the Union Electrical Company, of Berlin, who quoted 651,600 florins, the Allgemeine Electrical Company, of Berlin, coming next at 614,110 florins.

London.—The Shoreditch Borough Council has accepted tenders from the following firms for the supply of cables and sundries during the ensuing year:—The St. Helens Cable Company, Siemens Bros., G. Braulik, the London Electric Wire Company, the General Electric Company, Johnson & Phillips, Williamson and Joseph, Veritys Limited, Hands Limited, and A. Vandam & Co. For engineers' stores the tenders of G. Hatch, Limited, and Middleton Bros. have been accepted.

Wallasey.—The Tramways Committee have recommended that the tender of Messrs. Dick, Kerr & Co., Limited, for a supply of electric cars without air brakes (£11,800), and of cars with air brakes (£12,700), be accepted. The Committee have also recommended that the tender of Messrs. Askham Bros. & Wilson, Limited, Sheffield, for points and crossings at prices ranging from £3 10s. to £11 15s. (50s. each to be paid extra if special pattern were required,) be accepted. At the meeting of the U.D.C. on Thurday of last week, on the recommendations coming up for confirmation, Mr. J. Barber asked why Messrs. Askham's tenders had been accepted when the price in each case was in excess of that of other firms? He also wished to know the total cost of the tramways undertaking? Dr. Napier, in reply, said that Messrs. Askham's tender was accepted as that firm had, if not a monopoly, a preponderance of trade as regards supplying tramways equipment throughout the country, and the Committee on the advice of their expert, thought it well not to accept the cheapest tender, but to take that of a firm of wide experience whose name was exceedingly good. The total expenses of the undertaking were:—Buildings, £10,000; cables, £4,000; overhead equipment and bonding, £13,700; cars, £13,000; plant (condenser, boiler, buildings, cooling tank, generator, &c.), £9,350; tools, &c., £1,650; total, including rails, without street improvement, £130,000. As to when the electric service would be in operation, that depended largely on how the materials would be supplied and other factors, but he thought that they would have the cars running within 21 months. They had tied their contractors down very strictly to time limits, and he thought the work would be accomplished within the date mentioned. The minutes of the Tramways Committee were confirmed.

In completion of the transfer of the Wallasey Tramways to the D.C., a cheque for £21,240 was paid on Saturday week, by representatives of the D.C. to Mr. Hassall, solicitor representing the Wallasey United Tramway and Omnibus Company, Limited. Of the sum named, £20,500 was for the purchase of the undertaking as agreed at arbitration, and £740 as taxed costs, which had been reduced from £1,236.

A joint sub-committee of the Tramways, Gas and Electricity and Water Committees has recommended the acceptance of the following tenders:—Messrs. W. & J. Vicars, Limited, engine house extension (electric supply), engine and pump house (waterworks), and car sheds, workshops, and dwellings, £13,643 15s. 6d.; Messrs. Thomas Hill & Son, one Lancashire boiler, £700; Messrs. Galloways, Limited, condensing apparatus, £687 10s.; Messrs. Couper & Co., water-cooling tower, £349; Mr. Jos. Matthews, overhead travelling crane, £160; Lancashire Dynamo and Motor Company, engines (Galloways) and dynamos, £4,950; Messrs. E. Green & Son, economisers, £448; Messrs. R. W. Blackwell & Co., overhead equipment of tramways, £11,752 3s. 5d.; British Insulated Wire Company, Limited, cables, as per schedule of prices; Messrs. S. Z. de Ferranti, Limited, transformers, as per schedule of prices; and Messrs. R. W. Blackwell & Co., bonding of rails, as per schedule of prices.

FORTHCOMING EVENTS.

Friday, April 12th.—At 8 p.m. The Institution of Junior Engineers. Meeting at the Westminster Palace Hotel. Paper on "Iron-lined Tunnelling Construction" by Mr. A. Woodroffe Manton.

Saturday, April 13th.—At 3.30 p.m. The Institution of Junior Engineers. Visit the Great Northern and City Railway Works, to inspect the plant described in Mr. Manton's paper.

Wednesday, April 17th.—Institution of Electrical Engineers (Birmingham Local Section). Meeting in the Physical Theatre, The University, Birmingham. Paper on "Polyphase Equipment in Factories" by W. Wyld. And, if time permit, Mr. A. C. Eborall's paper "Some Notes on Polyphase Sub-station Machinery," will be read in brief abstract for discussion.

Thursday, April 18th.—At 8 p.m. Institution of Electrical Engineers. Meeting at Institution of Civil Engineers, Great George Street, S.W. Replies of Mr. H. Ravenshaw and Mr. S. F. Walker to the discussion on their papers read at the last meeting. "Test Room Methods of Alternate Current Measurements," by A. Campbell, associate member; "Note on the Use of the Differential Galvanometer," by C. W. S. Crawley, member. The announcement of the Council nominations for the Council, 1901—1902, will be made at this meeting.

At 8 p.m. Röntgen Society. Ordinary General Meeting, at 20, Hanover Square.

Friday, April 19th.—At 9 p.m. Royal Institution. Discourse by Prof. J. J. Thomson, F.R.S., on "The Existence of Bodies smaller than Atoms."

Tuesday, April 23rd.—At 7.30 p.m. Annual meeting of the Manchester Section of the Institution of Electrical Engineers.

NOTES.

Smoke Abatement. — The Berlin correspondent of the *Standard* states that the committee of experts appointed by the Prussian Government some time ago to report on devices for preventing or abating smoke from fires and furnaces, recently concluded its inquiries, and the measures it proposes will shortly be notified. The Ministers, however, have already instructed the managers of State factories, &c., to do all they can to prevent or consume the smoke from their fires, and, if necessary, to have smoke-consuming appliances constructed. Municipal and provincial authorities have also been asked to do the same, and it is pointed out that, according to the report of the above-mentioned committee, they will not suffer any pecuniary loss. The Minister of Commerce has also instructed the presidents of all the provinces to take steps for preventing the unnecessary production of smoke, and, if need be, to issue regulations.

The First Pacific Cable Company.—The following is extracted from the "Obituary" column of the *Times*:—

The death is reported from Washington, of paralysis, at the age of 70, of Cæsar Celso Moreno, one of those curious international characters developed from time to time. He was a native of Italy who, after seeing service in the Crimean War, went to Sumatra, where he incited the natives to revolt against Dutch rule. Later the French Government sent him to Tonquin, whence he drifted to China, where he formed a steamship company, the first to carry the flag of that country. Soon after the close of the American Civil War he landed in San Francisco, and was successful in procuring the enactment of laws, bearing his name, for the protection of the coast fisheries. In 1872 he organised a Pacific cable company, in which some leading American financiers were interested, and obtained a charter from the United States Congress authorising the construction of the cable. In carrying out this task he visited the Sandwich Islands, where he gained the confidence of the late King Kalakana of those islands. When the latter's Cabinet refused to approve a loan of $1,000,000 to assist in the laying of Moreno's projected cable the King dismissed the members and selected four new ones, with the adventurous wanderer as Prime Minister. The latter remained in office only five days, during which time he conducted the public business with a high hand. After his fall he still remained a favourite with the King, who secretly commissioned him as Minister to the United States and to every Court in Europe. This diplomatic relation did not last long, as, in obedience to adverse public sentiment, the appointments were soon revoked. In 1882 Moreno returned to the United States, and thenceforth, after his chequered and stormy career, lived quietly in Washington.

Appointments Vacant.—The Southampton T.C. are going to advertise for a tramways manager at £350 per annum. It is intended that only one who has had previous experience in the traffic management of electric tramways shall be appointed. An electrical engineer is wanted by the Salford Corporation for superintending cable-laying work and the erection of the tramways overhead electrical equipment, at £150 per annum. A junior mains assistant at £120 per annum, and a shift engineer at £150 per annum, are wanted for Manchester. The Willesden Guardians want a consulting electrical engineer for the installation for the new Infirmary. See "Official Notices."

Personal.—Mr. T. A. Rose, late managing director of Rose & Bird, Limited, and subsequently works manager of the Crystal Electric Lamp and Rose & Bird, Limited, has recently been appointed general manager to the Berrenberg Electric Lamp Syndicate.

Mr. J. H. Rider's colleagues and friends at Plymouth presented him with a tea and coffee service on leaving to take up his position as electric tramways engineer with the London County Council.

Mr. W. E. Barras, on resigning the position of foreman of the glass-house at the Ediswan Electric Light Works, was recently presented with a handsome marble clock by the staff.

Sir David L. Salomons, Bart., having resigned his seat on the board of the City of London Electric Lighting Company, Limited, in consequence of ill-health, Mr. George Herring has been unanimously elected chairman.

Mr. Wm. McClelland has been presented by the clerical staff of the Manchester Corporation electric works with a handsome gold watch in recognition of the eminent services he has rendered to the department.

Mr. Charles Garnett has been appointed borough electrical engineer at Darwen, in place of Mr. Stanley Clegg, who goes to Lincoln. Mr. Garnett has been assistant at Darwen since the works were opened.

Society of Arts.—The arrangements for April and May include the following:—

Monday, April 22nd, 29th, May 6th and 13th, 8 p.m. (Cantor Lectures.) Sir W. C. Roberts-Austen, K.C.B., F.R.S., "Alloys."

Wednesday, April 24th, 8 p.m. (Ordinary meeting.) Mr. Alexander Siemens, "Patent Law Reform."

Friday, April 26th, May 3rd, 10th and 17th, 8 p.m. (Howard Lectures.) Mr. Alfred C. Eborall, M.I.E.E., "Polyphase Electric Working."

Wednesday, May 15th, 8 p.m. (Ordinary Meeting.) Mr. Guglielmo Marconi, "Syntonic Wireless Telegraphy."

Steam Pipe Explosion.—It is stated that at about 5 p.m. on 2nd inst. an explosion occurred at the South Street generating station of the Metropolitan Electric Supply Company. It appears that a steam pipe burst, killing one and injuring other employés. At the inquest it was stated that Hopcraft, the deceased boiler cleaner, was in the act of drawing the fire from No. 11 boiler when the explosion occurred. The coroner adjourned the inquiry in order that the jury might view the premises.

German Electro-chemical Society.—The general meeting of the German Electro-chemical Society is to be held at Freiburg (Baden) from the 17th to the 20th inst. Quite a number of papers are to be read, including one by Herr R. von Lieben on "A New Electro-chemical Phonograph," and one by Dr. Alfred Coehn on "The Electro-chemical Properties of Acetylene." A number of visits to works of interest are also being arranged.

Manchester Overhead Wires.—The Manchester Tramway Committee have decided to request the National Telephone Company to immediately remove all the overhead wires on the three tram routes to be first opened, and place them underground, and further to remove the overhead telephone wires on other routes as quickly as possible; it being understood that this request applies only to wires within the areas in which the company already have power to use underground wires. All the wires in other areas are to be dealt with later under conditions and terms yet to be agreed upon.

Business Announcement.—The Blackman Ventilating Company, Limited, have acquired from Mr. James Keith, C.E., his business as heating engineer (with departments in gas and hydraulic work), carried on at Farringdon Avenue, E.C., and at his foundries and engineering works at Arbroath. The new name of the company will be "James Keith and Blackman Company, Limited."

Lectures.—A special evening course of lectures and laboratory work on "Alternating Currents" is to be delivered at King's College, commencing on April 29th. Prospectuses may be obtained from the secretary.

Before the Rochdale Junior Engineers' Association recently, Mr. G. L. Adamson lectured on "The Distribution of Electrical Energy."

Last week Mr. Bell, city electrical engineer, read a paper before the Aberdeen Mechanical Society on "Methods of Charging for Electrical Energy."

To British Manufacturers.—The *Westminster Gazette* says that British manufacturers are being urged to give attention to the production of "carborundum" and artificial graphite, and to the manufacture of carbons for electric lighting, the cathodes and anodes in electro-chemistry, and other purposes. Attention is also called to the business of re-rolling steel rails, which has existed in the United States for several years, and is still extending.

Branch Office.—Messrs. Nalder Bros. & Thompson, Limited, notify that they are removing their branch office at Holborn, where Mr. E. R. Roberts represents them, from No. 2, Holborn Place, to No. 6, just opposite. This, of course, does not in any way affect the principal offices at 34, Queen Street, to which all correspondence should be addressed.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Amazon Telegraph Company, Limited (44,532).—This company's annual return was filed on February 28th, when the entire capital of £250,000 in £10 shares had been taken up and paid for in full. Mortgages and charges, £200,000.

Argentina Electric Traction Company, Limited (61,211).—This company's annual return was filed on January 18th, when the entire capital of £500,000 in 100,000 shares of £5 each had been taken up. No calls have been made, but the shares are to be paid for wholly in cash. No mortgages or charges.

Renewable Electric Lamp Company, Limited (63,144).—This company's annual return was filed on February 12th, when 30,000 preference and 100,000 ordinary shares were taken up out of a nominal capital of £150,000 in £1 shares (50,000 preference). 10s. per share has been called up on 30,000 preference and 1,074 ordinary shares, resulting in the receipt of £15,535 15s. £1 5s. remains in arrears. 98,926 ordinary shares are considered as fully paid. No mortgages or charges.

English Electro-Metallurgical Company, Limited (62,225).—This company's annual return was filed on February 27th, when the entire capital of £700,000 in £1 shares (300,000 preference) had been taken up. 15s. per share has been called up on 200,000 preference shares, resulting in the receipt of £101,512 10s. £48,487 10s. remains in arrears. 400,000 ordinary and 100,000 preference shares are considered as fully paid. No mortgages or charges.

Newcastle and District Electric Lighting Company, Limited (28,022).—This company's annual return was filed on March 2nd, when the entire capital of £200,000 in £10 shares had been taken up; £9 has been called up on each of 10,000 and £1 on each of the remaining 10,000 shares, resulting in the receipt of £100,000, in addition to which £214 has been paid in advance of calls. Mortgages and charges, £47,080.

Telegraph Construction and Maintenance Company, Limited (1,147 C).—This company's annual return was filed on March 21st, when the entire capital of £448,200 in 37,350 shares of £12 each had been taken up and paid in full. No mortgages or charges.

South Lancashire Electric Traction and Power Company, Limited (67,974).—This company's annual return was filed on February 28th, when 51,132 preference shares were taken up out of a nominal capital of £850,000 in 600,000 preference and 250,000 ordinary shares of £1 each; 6s. per share has been called up, a further aggregate amount of £4,531 4s. being due on February 22nd. £11,801 has been paid, including cash in advance of calls. Mortgages and charges, £500,000.

Mexican Gas and Electric Light Company, Limited (18,223).—This company's annual return was filed on February 27th, when the entire capital of £100,000 in 5,000 shares of £20 each had been taken up. All the shares are considered as fully paid. Mortgages and charges, £95,000.

Kensington and Knightsbridge Electric Lighting Company, Limited (26,193).—This company's annual return was filed on March 6th, when 21,000 ordinary, 10,000 first preference and 10,000 second preference shares were taken up out of a nominal capital of £350,000 in 50,000 ordinary, 10,000 first preference and 10,000 second preference shares of £5 each. £5 has been called up on each of 15,968 ordinary, 10,000 first preference and 10,000 second preference shares, resulting in the receipt of £179,396. £444 remains in arrears. 5,032 shares are considered as fully paid. Mortgages and charges, £90,000; debt in respect of debenture stock issued by this company in conjunction with the Notting Hill Electric Lighting Company, Limited, £100,000.

St. James's and Pall Mall Electric Light Company, Limited (26,015).—This company's annual return was filed to March 18th, when the entire capital of £300,000 in 20,000 preference and 40,000 ordinary shares of £5 each had been taken up and paid in full. Mortgages and charges, £150,000.

SUPPLY STATION ACCOUNTS.

Taunton Corporation Electricity Accounts.

The accounts of the Taunton Corporation electricity supply undertaking for 1898 and 1899 show the benefit which has been derived from the reorganisation of the works. The Corporation is fortunate in having on the staff of its consulting engineers the former borough electrical engineer, Mr. Couzens. Mr. E. J. B. Thornhill, the present resident engineer, having previously been under Mr. Couzens, is well acquainted with the local peculiarities, and to the continuity of policy must be attributed the successful results obtained. Although the net profit is slightly lower in the latter of the two years under review, this is easily explained by the reduction in revenue per unit as compared with the fall in total cost, which is itself by no means unsatisfactory for a small station in a district remote from the coalfields.

General Statement.

	1898.	1899.	Increase.
Total capital expenditure ...	£29,415	£41,369	£11,954
Number of units sold	171,083	215,620	44,537
Maximum load in KW.	220	243	23
Gross revenue	£4,456	£5,010	£554
Gross expenditure...	£2,406	£2,805	£399
Gross profit	£2,050	£2,205	£155
Average price per unit sold ...	5·71d.	5·29d.	—·42d.

The revenue derived from sale of energy has fallen over ¾d., and now stands just below 5½d. per unit, which is a reasonable figure for an undertaking supplying less than a quarter of a million units, of which less than two-thirds is taken by private consumers. The figures for the two years are:—

	Units generated.	Sales private.	Public lighting.	Total sold.	Number of public lamps.
1898 ...	225,958	105,853	65,230	171,083	58 arcs; 8 50-C.P.; 2 32-C.P.; 45 16-C.P.; 40 8-C.P.
1899 ...	271,780	133,866	81,754	215,620	67 arcs; 8 50-C.P.; 8 32-C.P.; 105 16-C.P.; 36 8-C.P.

Revenue Statement.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Sale of energy..	£4,067	5·71d.	£4,751	5·29d.	—·42d.
Meter rents	123	·17d.	144	·16d.	—·01d.
Sale of lamps, &c.	149	·21d.	58	·07d.	—·14d.
Sundry rents, premiums, &c.	117	·16d.	57	·06d.	—·10d.
Gross revenue ...	£4,456	6·25d.	£5,010	5·58d.	—·67d.

Notwithstanding an increase of £156 in the gross coal bill (which covers the fuel required to generate 45,822 additional units), this item has fallen nearly $\frac{1}{10}$d. per unit, and now stands at just over 1½d., showing that the higher efficiency of the new generating plant is making itself felt. Reductions under the other heads bring the works costs down by more than ¾d. to just below 2½d., but small increases in the general charges for salaries and management absorb part of this and leave the total cost, better by about ½d., at 3½d. per unit. The last item in the costs is a royalty payable to the free wiring company, and therefore ranks as a special charge against revenue.

Cost of Production.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Coal	£873	1·23d.	£1,029	1·15d.	—·08d.
Oil, waste, water, carbons and engine room stores.	214	·30d.	208	·23d.	—·07d.
Salaries and wages incurred in generation and distribution, and attending street lamps.	450	·63d.	534	·59d.	—·04d.
Repairs and maintenance of engines, buildings, boilers, dynamos, &c., and public lamps.	299	·42d.	177	·20d.	—·22d.
Works costs ...	£1,836	2·58d.	£1,948	2·17d.	—·41d.
Rent, rates and taxes ..	68	·09d.	78	·09d.	—
Management expenses, salaries of managing engineer, secretary, clerks, &c.	368	·52d.	535	·59d.	+·07d.
General establishment charges, stationery and printing, law charges and insurance	77	·11d.	105	·12d.	+·01d.
Other expenses, royalties, &c.	57	·08d.	139	·15d.	+·07d.
Total costs ...	£2,406	3·38d.	£2,805	3·12d.	—·26d.

The financial charges have increased by over £400, while the gross revenue is greater by about £550, but as the gross costs take £400 of this, leaving only £150 greater gross profit, the balance of £250 means a reduction of net profit by this amount. Taking the last three years we get:—

Net profits.		Allocated.	
1897	£44	To rates	£300
1898	751	To renewals account ...	904
1899	503	Balance	94
	£1,298		£1,298

For an undertaking of this size to benefit the rates and put a substantial sum aside to renewals is a sound and satisfactory position to achieve.

Profit Statement.

	1898.	1899.
Interest on loans and overdraft	£630	£975
Sinking fund for repayments	669	727
Net profit carried forward	751	—
" " to rates	—	300
carried to renewal fund	—	203
Gross profit	£2,050	£2,205

CITY NOTES.

Willans & Robinson, Limited.

The ordinary general meeting of the above company was held on Wednesday last week at the Cannon Street Hotel, Mr. Mark Robinson presiding.

In moving the adoption of the report, the Chairman said he was glad to be able to congratulate the shareholders upon a prosperous half-year, from the profits of which they were able to pay not only at the rate of 12 per cent. for this half-year itself, but also 2 per cent. with respect to the previous half-year, and yet were able to increase their "carry forward," while not stinting their usual contribution to the reserves. They virtually divided at the rate of 14 per cent. for the half-year. It seemed reasonable to hope that they might soon drop the word "bonus," and not fear to talk about a 12 per cent. dividend. In the two years over which this bonus-paying had extended, they had increased the "carry forward" by very little less than the bonus of a whole year. The points raised at the last meeting by Mr. Anderson and Mr. Peache had given rise to the long series of "cases" and "opinions" lately distributed to the shareholders. The main question raised was really that old and arguable question, what was profit and what was capital? The board made no secret of their belief that share premiums were profit and not capital, as some of their friends contended, and that view was confirmed by the auditors and by the three eminent counsel whom they consulted. The expenses incurred over the Paris Exhibition had been pronounced by counsel to be an entirely proper charge against the premiums. As they had the shareholders' sanction to it last time, they had now written off this charge against the premiums account. The money had been well spent, and the exhibition had greatly raised the credit of the Willans engine. They proposed, they would remember, to carry the balance of the share premiums to the reserve fund, to which Mr. Anderson objected, on the ground that the reserve fund was liable to be used "to equalise dividends"—in other words, might possibly be distributed among the shareholders. It was clear, as he said last time, that it was common practice thus to treat share premiums, and counsel gave no support to Mr. Anderson on the ground that share premiums were not profit—on the contrary, they said emphatically that they were profit. But there was a peculiar phrase in one of the articles which said that in their case dividends were only to be paid out of "profits arising from the business of the company," and two of the counsel thought that share premiums did not arise "out of the business of the company"; and all agreed in the statement that "it is open to question" whether share premiums might, in view of their peculiar article, be distributed as dividends. Mr. Anderson's objection to carrying any sum from the premiums

account to the reserve fund while the latter was in its present form was therefore justified, but his objection could be met immediately by merely ear-marking the amount in some way, so as to ensure that it should not be distributed. A reserve fund which could not be used in time of emergency—which, in plain English, meant cannot be applied to meet a loss, of course with the indirect result of helping profits, would be of little use, and it was fortunate that counsel were clear in their opinion that though premiums might not be distributed (in this company) as dividends, yet the right to charge special expenses against them was certain. They would be justified, therefore, in charging any serious loss to the reserve fund, even if it were made up entirely of share premiums, and he did not think anyone would say that a reserve fund could be applied to a more legitimate purpose. Very good progress had been made with the boiler works at Queensferry, which they thought would be second to no works of the kind in the country. There had been some temptation to hasten the proper development of this work by beginning to make boilers with incomplete appliances, and without waiting for the materials of their own manufacture which they intended to use. The recent discussion about water-tube boilers in the Navy, and the emphatic condemnation by the Admiralty Boiler Committee of the boilers hitherto chiefly fitted, had offered inducements to push forward the manufacture, in the hope of securing a larger share of the Navy orders which were, probably, soon to be placed. They were certain that this policy would be a mistake. There were enough Niclausse boilers now on order for the Navy to ensure a thorough trial, and they were satisfied as to what the result of fair competition must be. But if they felt sure that no Niclausse boiler was ever to be fitted in the Navy, they would not alter the plan of the works by one brick or one machine. The Navy had played almost no part in their forecasts; they did not depend upon it in any degree whatever. Some of them might remember that the Willans engine was once the approved, if not the only recognised, engine for dynamo driving in the Navy. For ten years, or thereabouts, they had never had a Navy order, nor had they tried for one, and he thought they would agree with him that they had done pretty well without. They could afford to bide their time. They believed that this new branch of their business was going to be of great value to them, and that the best way to make the most of it was to go to work with just that deliberation which they desired to adopt. Water-tube boilers were not a passing fashion. Their supremacy was assured, whatever some would-be guides of public opinion might assume. But the ruling type had still to be selected, and it would not be chosen just yet. The battle would not be to the most blatant, but perhaps to those who talked the least, and that was the attitude they desired to take up. No great sum had yet been sunk in the boiler works, though considerable liabilities have been incurred. Up to the end of December they had actually spent only £29,667, and the total even now was only about £51,000. But the liabilities upon buildings and plant nearing completion, and others which it would be necessary to enter into, were beyond the power of their present capital to deal with, locked up, as much of it necessarily was, in ways which added nothing to the producing power of the works. Increase in their stocks was an advantage; it put them in a better position for dealing with orders. And it might be said, further, that the maintenance of large stocks of manufactured parts was the very essence of their system. Without it there could be no true system of working to template and keeping all parts interchangeable. Though they had before told them that more money would be needed than was covered by the authority given two years ago, the necessity came even more quickly than they expected. The temptation was strong, when one planned extensions, and asked for more money for them, to plan them on the most modest scale which at the time seemed permissible, and to overlook a little the fact that in modern industry works and appliances must be of the completest kind, and the enterprise generally of the boldest, if it were to obtain the best results. That had been their system from the beginning, and they knew how well it had succeeded, and in all they had in view now they were not proposing to depart in any way from the well tried lines of their action in the past. In speaking of what they had in view, he did not wish to be misunderstood as suggesting any development of the business not already approved by the shareholders. It was only a question of how far the extension should go and how perfect it should be. As an instance, and referring to the Rugby, not the Queensferry works, they first intended to build extensions of certain shops. But as these arose and took shape, they saw more clearly than at first that many subsidiary departments might with great advantage be increased too, and ought to be increased if due proportion were to be observed throughout the scheme. An addition to the main foundry building seemed at first to meet the difficulty they experienced in getting satisfactory castings from outside. But the mere increase of scale made it more remunerative than before to go in for machine or pneumatic moulding. It was plain that such a shop would pay for itself, and they added it, and at the same time found that further savings would accrue if they built better places for fettling the castings and for storing patterns and moulding boxes. The larger engines they were called upon to build seemed at first to be sufficiently provided for by the extension of the machine shop and the erecting shops respectively. But with means for doing more actual work on engines came previously unnoticed opportunities for saving in other directions. A completer system of works railways, and more powerful and more numerous cranes were seen to offer ready means for further cheapening the work. Extension of electrical working was seen to promise economies, and a new power station already planned, though not ordered, was the result. Like considerations had applied in the new Queensferry works, and the result was the recommendation made in the report. It has been fully, and he might almost say, reluctantly considered, and it was made in the full conviction that it was in the best interests of the company—that was to say, that it would make each present shareholder better off in the future than he would be without this issue. They proposed to issue £150,000, half in preference and half in ordinary shares, the first instalment to fall due in May. So far as they could see at present, the issue price should be the same as last time, viz., £6 for preference shares, and £8 for ordinary. The old question had been raised of issuing at par, but they thought a moderate premium was in every way desirable, and they were sure that it agreed with the views of the great majority of the shareholders.

Mr. Holland seconded the motion, and thought the shareholders should have no hesitation in following the views of the directors seeing how correct they had been up to the present.

Mr. Donkin said he took it that the increase of capital would come to 50 per cent. increase.

The Chairman: That is so when all is issued.

Replying to further questions, the Chairman said that the works at Thames Ditton were simply used for making standard parts for the engines. Their relations with their workmen were never happier than now.

The report was then adopted.

Sir Gilbert Clayton East subsequently moved the necessary resolutions to increase the capital, as explained in the chairman's speech, and this was agreed to.

Dover Electricity Supply Company.

The annual meeting was held at the offices on Wednesday last week, Sir William Crundall presiding.

Sir William Crundall said that instead of paying what they expected, namely, 5 per cent. dividend, they would only be able to pay 3½ per cent. although this was an increase of ½ per cent. over the previous year. Had it not been for the price of coal they would have paid 5 per cent. The difference in the cost of coals was as near as possible 1½ per cent. He believed that next year they would certainly pay 6 per cent. or even more. They had a large contract with the contractors for the new Admiralty Harbour works which will practically come into operation and profit this company during this year. In addition to that they had other public lighting which meant an increase of profit, namely, the lighting of the Admiralty Pier and the Prince of Wales Pier, including the light-house. In addition to that they were negotiating with the Harbour Board at the present time for power for several electric cranes at the Admiralty Pier, also they had a largely increased number of applications for private lighting. During the last 12 months they had spent on capital nearly £10,000, the greater proportion of which was for plant and mains for the Admiralty Harbour works. The further expenditure of capital in the near future would probably be for the extension of mains only, as they had sufficient machinery in the station to enable them to supply for lighting purposes and power double the amount they did at the present time.

The engineer, Mr. Woodhouse, afterwards showed the shareholders the alterations and improvements that had been made in the machinery during the past year. These were principally the addition of a large continuous-current dynamo of 225 kw. capacity, directly driven by a steam engine of 335 b.h.p. To enable this engine to be placed in, the building has been lengthened some 21 ft. The dynamo has been added mainly to drive the motor plant at the eastern section of the Admiralty Harbour works, but in addition to providing all the energy required it will also drive the trams even if the line is considerably extended. Messrs. Pearson & Son have six electric concrete mixers at East Cliff, which require each 18 h.p. for mixing. In addition there are several 30-h.p. motors for the sawmills and the fitting shops at East Cliff.

Bromley Electric Light and Power Company.

Mr. F. E. Gripper presided at the annual meeting held on Monday last week. The report showed that the progress made by the company during the year has been satisfactory, the lamp connections in Bromley having increased from 7,337 to 13,395, whilst 4,987 are being supplied in Chislehurst. The sale of current has increased from £2,358 to £4,044. The result of the year's trading, including the balance, £1,020 18s. 2½d. brought forward from last year, shows a profit of £3,029 5s. 11d., and after payment of debenture and loan interest, amounting to £1,945 14s., and writing off the whole of the preliminary expenses, amounting to £243 15s. 8d., the amount available for dividend is £835 6s. 3d. The directors recommended the payment of a dividend at the rate of 4 per cent. for the year, and that £400 be placed to a reserve fund for the renewal of plant, leaving a balance of £125 13s. 2d. to be carried forward to the next account. Large extensions have been made to the works during the year, the buildings having been enlarged, and additional engine and boiler power added, and a large condensing plant put down, which will enable a considerable reduction to be made in the coal consumption.

The Chairman, in moving the adoption of the report, remarked that a great deal of the success of the company had been due to the liberal expenditure on mains at an early stage in its existence. In the capital expenditure there was a rather large amount, £3,500, for machinery, which represented increased boilers and dynamos and other machinery in the works, for they could not

supply additional light without additional machinery. That brought the total expenditure up to the end of the year to £56,000, and he remarked that they would have to spend almost as much in the coming year as they had spent during the past 12 months. They would have to make further additions to their boilers and dynamos, but they expected a large saving in their coal bill from the condensing plant which had been put down; while it had also got rid of all the annoyance and noise. They hoped, by that apparatus, to save something like 20 per cent. upon their coal bill, which was a considerable item. They spent nearly £1,200 upon coal last year, and they would use 50 per cent. more in the ensuing year, but he hoped it would not be at quite such a high figure as they had paid during the last 12 months. During the year they had laid about 7¼ miles of new mains through the district, but he did not expect they would put down quite so much during the coming year, as they had now laid the great network of mains, and would merely have to make additions. There would also be a considerable outlay on mains for supplying Bickley. The company had also enlarged their works very considerably, making their engine house and boiler house nearly double the size, and the place was now big enough to hold plant which would last them for eight or 10 years, and enable them to supply 50,000 to 70,000 lamps. What they hoped to see very largely increased was the free wiring which the company undertook. They had probably paid 30 or 40 per cent. more for coal than in the previous year. There was every prospect of coal coming back to its low figure. On the other side, they had sold £4,000 of current, and the net result was that they had made a profit on their sales of £1,812. The average price they had obtained for the light this year was only 4¾d. per unit—4·7d., while last year it was a little higher, being 4·81d., so that they had been selling the current at a slightly cheaper price than last year. The cost of the current was only 2·7d. this year, while it cost 3·1d. last year, so that they had made a considerable reduction in the cost of production.

Folkestone Electricity Supply Company.

The report of the directors presented to the fifth ordinary general meeting held at the company's works, near Shorncliffe Station, Folkestone, on Saturday, March 30th, reads as follows:—

The directors submit herewith a statement of the accounts and balance-sheet made up to December 31st last. Your directors have pleasure in reporting that the company continues to make satisfactory progress. Up to December 31st, 1899, the equivalent of 17,834 8-c.p. lamps was being supplied, whilst up to December 31st, 1900, the equivalent of 24,190 8-c.p. lamps was being supplied. It will be seen from the accounts that there is a profit on the revenue account of £2,930 5s. 2d., which, with the sum of £149 8s. 1d. brought forward from last year's accounts, and after allowing for interest on debenture stock and bank charges on temporary overdraft, shows a net balance for distribution of £2,345 2s. 4d. Had it not been for the great increase in the price of coal the balance for distribution amongst the shareholders would have been much larger. The coal bill this year exceeds that of the previous year by over £650. Out of this your directors recommend the payment of a dividend at the rate of 4 per cent., which will require £2,000, and the balance, £345 2s. 4d., to be carried forward to next year's accounts. The directors are pleased to report that the issue of £25,000 4½ per cent. debenture stock, in April last, was most successful. The stock was issued at 102 per cent., and was subscribed for nearly twice over. The directors have also been successful in obtaining a Stock Exchange quotation in respect of the ordinary share capital of the company. Under the company's regulations two of the directors, Messrs. G. Spurgen (chairman), and W. B. Hopkins, retire by rotation, but they are both eligible and offer themselves for re-election. The auditor, Mr. Richard White, also retires, but is eligible and offers himself for re-election.

Alderman George Spurgen, J.P., presiding at the meeting, said although the accounts did not show so large a balance as they could wish, this would have undoubtedly been much larger but for the abnormal price of coal. They had expended something like £12,000 on capital account during the year, and, so far as the receipts were concerned, their income from private lighting was £443 more and from public lighting £110 more, although the balance for distribution was only £97 more than last year. When the company was started they had no idea that the light would be taken up so freely as it had been. They started on what they thought prudent lines, and put in what was believed to be sufficient machinery for a certain number of years. But the increase had been very rapid, and they had extended their works greatly this year at considerable expense. He would point out that on their second year's working this company paid a dividend. In their first year they made a profit of something like £400. They carried that forward to the second year, and with the profit they made it enabled them to pay a dividend of 4 per cent., to place £400 to the reserve, and to carry forward a certain amount. Their coal bill was £600 more than last year. It took £500 to pay a 1 per cent. dividend, so that but for the increase in coal they could have paid 5 per cent. They hoped that this year coal would go back to its normal price, and they would earn more, and consequently be able to pay more dividend. Another thing which had depreciated their receipts was economies made by consumers in using the light, the result being that instead of getting 6s. 8¾d. per lamp as they did the first year of their working, they only got 6s. 1d. last year. That was due to people taking extra care in turning out their lights. At the end of the year they had an equivalent of 24,190 8-c.p. lamps installed; for the three months up to date they had installed 2,118 more lamps, making a total of over 26,000, and they had applications in hand for 128 more. They were extending their buildings, and had a large amount of machinery on order. They were also putting down a condensing plant, by which they hoped to save something like 25 per cent. on their coal bill. Last year, when they applied for £25,000 of debenture stock at 4½ per cent., that was most successfully issued at 102, being subscribed nearly twice over. They would shortly have to appeal for another £25,000, and he felt perfectly sure that the standing of the company would enable them to borrow that money at 4½ per cent. Unlike many electric light companies, their company had had no unproductive period, and he felt sure that, given anything like good luck in the future, they would increase their dividend next year and the year after that.

Guildford Electric Supply Company.

The annual meeting of this company was held last Friday week, when the Chairman (Dr. F. R. Russell), in moving the adoption of the report, stated that the net revenue showed a deficit, due to increased cost of coal and labour and the want of accumulator plant. New batteries were now provided, and although money had been borrowed for them at a high rate of interest the prospects were encouraging. The gross income was an increase of 38 per cent. on 1899, but the coal bill increased from £462 to £1,267, which amounted to nearly 4d. per unit of current generated. The new batteries reduced this to 2d., so that there had been a saving of £250 during the last three months. During 1900 they had 32 new customers.

Mr. Money Kent, in seconding the adoption of the report, said that without the coals the cost per unit was only 1·83d.

Mr. Money Kent, the retiring director, was re-elected, and Messrs. Hopps, Bankart and Warmington were re-appointed auditors.

In reply to Mr. Fentum Phillips, the Chairman admitted that the company had a contract to supply the Brewery Company at 3¼d. per unit. This was an unfortunate contract, but it had paid them at first and had another year to run.

Blackheath and Greenwich District Electric Light Company.

The report of the directors to December 31st last, states that the company commenced the supply of electricity from its own generating station on February 14th, 1900. This was much later than was originally intended, and the delay involved a serious loss of revenue. Part of this loss, to the extent of £1,200, has been recovered from the contractors as compensation for delay in the delivery of the machinery. The business is steadily increasing. The number of lamps connected on February 14th, 1900, was equivalent to 5,957 of 8-c.p., and on December 31st was equivalent to 14,473. During the same period the number of consumers increased from 132 to 342. On March 31st the connections amounted to an equivalent of 16,520 8-c.p. lamps, and applications for a further 4,907 8-c.p. equivalents have been received, making a total of 21,427 8-c.p. connected and applied for. The issue of 4½ per cent. debenture stock, to the amount of £100,000, authorised in July last, was fully subscribed. Owing, it is stated, to the fact that the generating station has been in operation for less than a year, the accounts show but a small profit, but the directors, in view of the increasing demand, look in the immediate future for a profitable development of the company's business.

Windsor Electrical Installation Company.

Mr. Drury Lavin presided at the annual meeting of this company held recently. The report, of which he moved the adoption, stated that the net profit for the year was £4,372 11s. 11d., which, together with a balance of £690 12s. 3d. brought forward, made the total amount available for distribution £5,063 4s. 2d. After payment of a dividend of 8 per cent. for the year, free of income-tax, recommended by the directors, £1,400 14s. 2d. remained, of which it was recommended the sum of £750 should be added to the depreciation, renewal and reserve fund, and out of the remainder the shareholders would be asked to vote £350 for directors' fees.

The Chairman said that the company had had another very successful year, and after placing a large amount to the reserve fund, was able to declare a dividend of 8 per cent. for the year, an interim dividend of 3 per cent. having been already paid. The company has increased its number of directors by the election of Mr. de Salis, and Mr. A. H. Thornton was elected a director to fill the vacancy caused by the retirement of the Rev. S. Whitcombe.

Babcock & Wilcox, Limited.

Mr. J. Dewrance presided at the annual meeting held at the offices in London on Wednesday. In moving the adoption of the report, he said that the reserve fund of £130,000, on which they prided themselves in the old company, had, unfortunately, been ruled out in the reconstruction of the company, but it was now represented by certain assets which had been purchased by the new company. They would now start a new reserve fund by placing to the profit made in the interval of reconstruction, the 10s. premium on the new issue of £90,000 of shares. The year had been one of exceptionally hard work, and he hoped the shareholders would be satisfied with it.

Sir W. Arroll, M.P., seconded the motion, which was carried.

The Chairman said there were a great many croakers who thought we were on the brink of a great depression in trade. Personally, he did not think so, and he was of opinion that when the political atmosphere cleared there would be an increase.

Prospectus.

The Charing Cross and Strand Electricity Supply Corporation is, until to-night (Friday), inviting applications for £250,000—4 per cent. debenture stock issued at par. The stock will be secured by a floating charge on all the corporation's assets, present and future (other than the City undertaking, and the assets belonging thereto, and the moneys invested in the Charing Cross and City Electric Company, Limited). A map which accompanies the prospectus shows the areas of supply over which the company has powers, with the relative positions of the generating and sub-stations. The capital already issued by the company is £500,000, made up of equal portions of ordinary and preference shares. The purposes for which the present quarter-million issue is required are stated as follows:—

(*a*) For the building of the sub-station at St. Martin's Lane, and the equipment of the station with the necessary machinery, plant, accumulators, and apparatus.
(*b*) For the erection of a larger general office to accommodate the increased staff.
(*c*) For supplementing and considerably extending the corporation's system of mains used for the purposes of the undertakings on which the stock is charged.
(*d*) For the purpose of advancing moneys to the Charing Cross and City Company.
(*e*) For providing additional working capital.

It will be seen that £10,000 will be sufficient to cover the 4 per cent. debenture interest, and as the ordinary and other dividends are well assured by the very progressive nature of the business, the investment looks to us to be a particularly safe one.

Stock Exchange Notices.—Applications have been made to the committee to appoint a special settling day in and to grant a quotation to—City and South London Railway Company—Further issue of 10,000 ordinary shares of £10 each, fully paid, Nos. 60,001 to 70,000, and the following securities to be quoted in the Official List:—Willans & Robinson, Limited—Further issue of 10,000 ordinary shares of £5 each, fully paid, Nos. 80,001 to 90,000. Central London Railway Company—Provisional scrip certificates (fully paid) for £698,201 4 per cent. debenture stock, and has ordered same to be quoted in the Official List.

Dudley, Stourbridge and District Electric Traction Company.—On Thursday of last week an extraordinary meeting of the shareholders of this company was held at the offices, Donington House, Norfolk Street, W.C., for the purpose of making certain alterations in the articles of association of the company, when the proceedings, our representative was informed, were of a private character.

Oriental Telephone and Electric Company.—The directors have resolved to recommend, subject to final audit of the accounts, the payment of a further dividend of 8·40d. per share, free of income-tax, making with the interim dividend paid on November 1st last, a total of 6 per cent. for the year ended December 31st, 1900.

City of London Electric Lighting Company.—Mr. G. Herring presided at an extraordinary general meeting held at Winchester House on Wednesday, when certain resolutions for altering the articles were confirmed.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending April 5th were £533 0s. 3d.; corresponding week last year, £417 4s. 8d.; increase, £115 15s. 7d. Total to date, £5,622; corresponding period last year, £5,013; increase, £609. Miles open, 8½. Partly electrical and steam.

Blackpool and Fleetwood Tramways.—The receipts for the week ending April 6th were £384; corresponding week last year £206; increase, £178. Total to date, £2,268; corresponding period last year, £2,279; decrease, £11.

Bristol Tramways and Carriage Company.—The receipts for the week ending April 5th were £4,027 5s. 2d.; corresponding period last year, £2,738 4s. 1d.; increase, £1,289 1s. 1d.

Central London Railway.—The receipts for the week ending April 6th, were £5,654; previous week, £6,228; decrease, £574. Total receipts to date (14 weeks), £84,889. Miles open, 6.

Dover Corporation Tramways.—The receipts for the week ending April 6th were £221 7s. 2d.; corresponding week last year, £160 0s. 9d.; increase, £61 6s. 4d. Total to date, £2,219 12s. 2d.; corresponding period last year, £3,028 19s. 8d.; increase, £190 12s. 6d. Miles of track open, 8; Car miles run, 1901, 5,114; 1900, 4,948. Number of cars, 1901, 12; 1900, 11.

Dublin United Tramways Company.—The receipts for the week ending April 5th were as follows:—D. U. T. Co., electric cars, £3,205 16s. 3d.; D. S. D. Co., electric cars, £714 12s. 6d.; total £3,920 8s. 9d.; corresponding week last year—D. U. T. Co., electric cars, £5,016 6s. 11d.; ditto, horse cars, £73 17s. 8d.; D. S. D. Co., electric cars, £1,753 6s. 1d.; total, £6,843 10s. 8d.; decrease, £2,923 1s. 11d.; aggregate to date, £51,336 17s. 4d.; aggregate to date last year, £50,499 15s. 10d.; increase, £837 1s. 6d. The mileage worked is 45 miles electrically, as against 42 miles electrically, 2 miles by horses, for the corresponding period last year. (Queen Victoria's visit, 1900.)

Glasgow Corporation Tramways.—Receipts for week ending March 30th, 1901, £7,999 3s. 11d., as compared with £8,477 17s. 3d. for same period last year.

Liverpool Corporation Tramways.—Receipts for the fortnight ended March 30th, £15,829 0s. 8d., against £13,767 4s. 5d. in the corresponding fortnight last year. Passengers carried 3,419,840, against 2,606,650.

Liverpool Overhead Railway.—The receipts for the week ending April 7th were £1,607; corresponding week last year, £1,317; increase, £290. Total to date, £20,813; corresponding period last year, £19,454; increase, £1,359. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

The eyes of the Stock Exchange wait upon the Budget. Until it is known what steps the Government will take with regard to the financing of the war, markets are not likely to move much in either direction. Some there are who profess to see in the strained relations between Russia and Japan a menace to investment securities generally, but in our opinion it is the money market which now rules the situation. Notwithstanding the payment of the April dividend on Consols, there is a tightness in Lombard Street which shows but slight sign of relaxation. Under this combined pressure of money and politics, the heavier departments in the Stock Exchange are exceedingly quiet. In the list of telegraph securities there is only a trinity of changes recordable, while the electricity supply section exhibits but four alterations.

Central London Ordinary shares are ¼ better. For this rise must be thanked the success of the new electric cars of the London United Tramways Company. The latter provided London with a new form of entertainment during the holidays, and Hammersmith all but stood on its head with excited pride over its latest toys. Certainly the new system of traction ought to prove another most useful feeder to the Central London—if it needed one. Had London Uniteds been dealt in by the Stock Exchange, there would no doubt have been a sharp rise in them on Tuesday. As it is, the Debentures are a point harder at 103¼, and Imperial Tramways shares are 22, *ex* dividend, both in the London and Bristol Exchanges.

Metropolitan District stock has declined to 28 as a comment upon the proposed reduction in season ticket fares, but Metropolitan Consolidated is harder at 74. It was interesting to hear Mr. Arnold Hills declare at the meeting of the Thames Ironworks Shipbuilding and Engineering Co. that his company with others had prepared designs for the electrical equipment of the District. Evidently the scheme is still alive. Mr. Hills' speech, however, was interesting in a much more important point than this relating to the District Railway. He spoke of an English combination of electrical engineers which had been formed to compete against the powerful German and Yankee syndicates, and its hopeful tone encouraged the market to put up Brush Ordinary to the tune of 2s. 6d. But as the Preference were lowered a similar amount, the net result is nothing much. Thames Ironworks Preference shares are 15s. middle, and the 4 per cent. irredeemable First Mortgage Debentures are standing at 90.

Many inquiries are reaching the Stock Exchange as to a quotation for Great Northern and City Railway Debenture stock. We regret to tell holders that the stock is practically unsaleable owing to its lack of marketability. The company's Preference shares, now £10 fully paid up, are about 9, and difficult to deal in either way.

In the Electricity Supply section, falls of 10s. each have occurred in Brompton Preference and City of London Preference. Allowing for the dividend on City Preferences, there has been a decline of 14s. a share during the past fortnight. The Ordinary have not moved, but County of London Ordinary are ½ higher at 9, the shares being fancied upon the chairman's speech at the recent meeting.

Edmundson's new Preference are 5½ to 6, and the latest emission of Metropolitan shares goes out 9—10. No change took place in the prices of Blackheath and Greenwich shares upon the issue of a hopeful report. The Ordinary are 10s., and the 4½ per cent. Debenture stock, with 75 per cent. paid, commands a premium of 2½ per cent. As regards quotations of provincial descriptions, Bournemouth and Poole Electric Supply Ordinary now stand at 12, the Preference being 10½. Folkestone Ordinary are 5½, the fraction representing the premium over par value. Hove Electrics maintain their price at 8, while Oxford Ordinary are 6. This last trio all adopt £5 as the denomination of their shares, which are fully paid in each instance.

A drooping tendency in Eastern Preference stock is the only noticeable feature in the Telegraph market. Beyond this there is not a single recordable alteration. National Telephone third Preferences are marked out for this week's fall, and are down an eighth.

British Electric Traction shares are steady—are inclined even to harden a little upon the opening of the Merthyr Tydfil Electric Light Railway, which has been constructed for the local undertaking by the British Electric. As purchase price the latter is to receive £66,000.

The one interesting new flotation of the week is the quarter of a million 4 per cent. Debenture stock offered by the Charing Cross and Strand Electric Company at par. A fortnight ago we were able to hint at this issue, and the prospectus fully confirms our information. The stock is a good one, and the market premium of 3 per cent. seems quite justifiable. Very little stock has changed hands so far. Partly as a result of this emission Charing Cross Preference shares eased off ¼. Certainly the new Debenture stock is the more attractive investment of the two securities.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation April 2nd.	Closing Quotations April 10th.	Business done during week ended April 10th, 1901. Highest.	Lowest.
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —102	99 —102	...	...
119,700	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	55 — 65	55 — 65	...	...
822,700	Anglo-American Telegraph	Stock	£3 9s.	73/6	3½%	51 — 54	51 — 54	...	...
3,088,540	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	95 — 97	95 — 97	96	95½
3,088,540	Do. do. Deferred	Stock	18s. %	£1 7s.	5s. %	8¼— 8⅜	8¼— 8⅜	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	...	3 — 3¼	3 — 3¼	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	160 —170	160 —170	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	101 —103 xd	101 —103	...	...
16,000	Cuba Telegraph	10	8 %	7 %	...	7½— 8¼	7½— 8¼	...	...
6,000	Do. 10 % Pref.	10	10 %	...	...	16 — 17	16 — 17	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3 — 4 xd	3 — 4	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	9 — 10 xd	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 —104%	100 — 104%	...	...
60,710£	Direct United States Cable	20	3½%	3 %	3 %	9⅜—10¼ xd	9⅜— 10¼	...	...
108,300	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	143 —148	143 —148	145	143
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	93 — 96	92 — 95	95	93
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	113 —117	113 —117	...	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	...	14¼— 14⅜	14¼— 14⅜	14⅜	...
50,000	Do. Nos. 250,001 to 300,000 (iss. at £3 pm. all pd.) ...	10	...	...	...	13⅜— 14¼	13⅜— 14¼	...	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	111 —116	111 —116	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	99 —102	99 —102	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	101 —104%	101 —104%	...	...
180,227	Globe Telegraph and Trust	10	5⅛%	5⅛%	...	9⅜— 10¼	9⅜— 10¼	10⅛	9⅜
180,042	Do. do. 6 % Pref.	10	6 %	...	...	14⅜— 15½	14⅜— 15½	14 13/16	...
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	...	32 — 34	32 — 34	...	...
82,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	47 — 51	46 — 50	...	...
100,000£	London Platino-Brasilian Telegraph, 6 % Debs.	100	...	...	...	103 —106	103 —106	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	2½%	...	¼— ½	¼— ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	⅝— 1	⅝— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	3⅛— 3⅜	3⅛— 3⅜	3 3/16	...
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	10 — 12	10 — 12	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅛— 4⅝	4¼— 4½	4⅜	4¼
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	90 — 93	90 — 93	...	...
500,000	Do. 4 % Deb. Stock Red.	100	...	...	4 %	96 — 99	96 — 99	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	¾— 1⅛	¾— 1⅛	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	99 —102	99 —102	...	...
11,839	Reuter's	8	5 %	5 %	...	7½— 8½	7½— 8½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	124 —129	124 —129	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	4½— 5	4½— 5	...	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4¾— 5¼	4¾— 5¼	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	103 —106	103 —106	...	...
171,000	West African Telegraph, 5 % Debs....	100	...	...	...	97 —100	97 —100	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	⅛— ¼	⅛— ¼	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	99 —102	99 —102	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	13⅜—14¼	13⅜— 14¼	14 1/16	14
75,000	Do do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	101 —104	101 —104	...	...
348,777	Do. do. 4 % Deb. Stock Red.	100	...	...	...	102 —105	102 —105	...	...
88,321	West India and Panama Telegraph	10	2 %	8%	...	⅜— ½	⅜— ½	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	6 — 7	6 — 7	6 5/16	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	5 — 7	5 — 7	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	103 —106	103 —106	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	7⅞— 8¼	7⅞— 8¼	...	...
12,000	Do. do. 7 % Cum. Pref....	5	...	...	...	8⅛— 9¼	8⅛— 8⅝	...	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	9 — 10 xd	9 — 10	...	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 5⅝	5 — 5½	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5½%	5⅝— 6¼	5⅝— 6¼	6 3/16	...
150,000	Do. do. do. % Deb. Stock Red. ...	Stock	...	...	...	109 —112	109 —112	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	6 %	4 %	...	7 — 8	7 — 8	7 1/16	7⅞
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	...	...	12½—13½ xd	12 — 13	12⅝	12⅜
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	121 —126	121 —126	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	4 %	4 %	8 — 9	8½— 9½	8⅝	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	...	...	11½— 12½	11½— 12½	12⅛	12
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	106 —109	106 —109	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	7 %	...	...	4⅜— 5¼	4⅜— 5¼	5	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	103 —106	103 —106	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1¼— 1⅜	1¼— 1⅜	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	3½— 4½	3½— 4½	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	98 —101	98 —101	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	11½— 12½	11½— 12½	12¼	11⅞
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	110 —113	110 —113	...	...
250,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	97 —100	97 —100	...	...
6,452	Notting Hill Electric Lighting	10	6 %	7 %	7 %	15½— 16½	15½— 16½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	13½— 14½	13½— 14½	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	...	...
150,000	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	98 —101	98 —101	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2½— 3½	2½— 3½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000... ...	5	12 %	13 %	10½%	11½— 12½	11½— 12½	12⅛	...

* Subject to Founders Shares. Quotations on Liverpool Stock Exchange.
Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation April 2nd.	Closing Quotation April 10th.	Business done week ended April 10th, 1901. Highest	Lowest
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	7½ — 8½	7½ — 8½	...	...
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	91 — 95	91 — 95	...	...
45,000	British Electric Traction	10	6 %	...	...	15 — 16	15 — 16	...	...
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	11½ — 12½	11½ — 12½	12⅜	12 3/16
350,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	119 —122 xd	119 —122	120½	...
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	1/16 — 3/16	1/16 — 3/16	...	...
50,000	† Do do. 6 % Cum. Pref., 1—50,000 ...	...	...	...	...	3/16 — 5/16	3/16 — 5/16	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	85 — 90	85 — 90	...	...
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	10 — 11	10 — 11	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5⅝ — 6½	5⅝ — 6½	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	5 %	6 %	...	1½ — 1⅝	1⅝ — 1⅞	1⅞	1⅝
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2⅛ — 2⅜	2 — 2⅛	2 1/16	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	103 —108	103 —108	...	...
108,710	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	101 —103	101 —103	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	...	15 — 16	15 — 16	15	...
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½ — 6	5½ — 6	5⅞	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	109 —113	109 —113	112	111
206,297	Central London Railway, Ord. Shares	10	...	...	...	8⅝ — 9½	9 — 9½	9¼	9
78,703	Do. do. Pref. half-shares	5	...	...	...	4⅜ — 5¼	4⅜ — 5¼	...	...
78,703	Do. do. Def. do.	5	...	...	...	4 — 4½	4 — 4½	...	...
855,000	City and South London Railway	Stock	2⅛%	1⅞%	1¼%	46 — 50	46 — 50	...	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	4 — 5	4 — 5	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½%	...	3½ — 4	3½ — 4	...	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	100 —103	100 —103	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	1½ — 2	1½ — 2	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	...	3 — 4	3 — 4	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	87 — 89	87 — 89	...	...
100,000	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	94 — 98 xd	94 — 98	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	1⅝ — 2¼	1⅝ — 2¼	1 13/16	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	...	...	2½ — 3	2½ — 3	...	...
182,500	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	101 —104	101 —104	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600	10	7 %	7 %	...	10 — 11	10 — 11	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	20 %	15 — 16	15 — 16	16	...
35,000	Do. do. do. 4½ % Pref.	5	7 %	...	...	5½ — 6	5½ — 6	5⅞	5½
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	107 —111	107 —111	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21 — 22	...	...
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3⅜%	3½%	7⅜ — 7⅞	7⅜ — 7⅞	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	13 — 13½	13 — 13½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17½%	37 — 41	37 — 41	39½	39¼
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	... %	...	101 —104	101 —104	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	8 %	12 %	...	11 — 12	11 — 12	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5½ — 6	5½ — 6	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	94 — 97	94 — 97	94½	...

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, 3/—4/-
National Electric Free Wiring, 12/6 paid, 7/6—11.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 16—17.
Do. do. Pref. (£10 pd.), 10—11.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 11—12; 1st Preference Cumulative 6 % £5 (fully paid), 6½—7. Dividend, 1900, on Ordinary Shares 12 %.
*T. Parker, £10 (fully paid), 16½.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (February 21st, 1901).

MARKET QUOTATIONS, Wednesday, April 10th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a ,, ,, ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17 10	£17 10	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25	£25	..
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	8¾d.	8¾d.	..
a ,, Caustic (75/80%) ..	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	64/-	64/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6 5s.	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
,, Bichromate, casks ..	per lb.	2¾d.	2¾d.	..

METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£75 to £130	£80 to £145	dec.
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	8¼d.	8¼d.	..
c ,, Wire, basis	per lb.	8d.	8d.	..
c Copper Tubes (brazed) ..	per lb.	11d.	11d.	..
c ,, ,, (solid drawn) ..	per lb.	10½d.	10½d.	..
g Copper Bars (best selected) ..	per ton	£84	£84	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£84	£84	..
g ,, Rod	per ton	£84	£84	..
e ,, (Electrolytic) Bars ..	per ton	£82	£82	..
e ,, ,, Sheets ..	per ton	£90	£90	..
e ,, ,, Rod ..	per ton	£84	£84	..
e ,, ,, H.C. Wire	per lb.	9¾d.	9¾d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/9	3/6½ to 3/7	inc.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	45/-	45/6	6d. dec.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£10	£10	..
g Lead, English Ingot	per ton	£13	£13 10	10s. dec
g ,, ,, Sheet	per ton	£15	£15	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 2 6	£9 2 6	..
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/0½ to 1/3	1/0½ to 1/3	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£4	£4	..
p Silicium Bronze Wire	per lb.	10½d. to 1/0½	10½d. to 1/0½	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i ,, ,, in bars		£58	£58	..
g Tin, block	per ton	£119 to £120	£117 10 to £118	30s. inc.
g ,, foil	per lb.	1/9	1/9	..
n ,, wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£35 to £65	£40 to £70	dec.
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	9d.	9d.	..
j ,, Best Flax, 6 lea.	per lb.	6d.	6d.	..
j ,, Hemp, 3 ply 10 lbs. ..	per lb.	4¾d.	4¾d.	..
j ,, ,, Russian, 10 lbs. ..	per lb.	5¾d.	5¾d.	..
j ,, Jute, 180 lbs. rove ..	per ton	£14	£14	..
k Zinc, Sh't. (Vielle Montagne bnd.)	per ton	£21	£21	..

Quotations supplied by { a Messrs. G. Boor & Co. b The British Aluminium Co., Ltd. c Messrs. Thos. Bolton & Sons. d Messrs. F. Wiggins & Sons. e Messrs. Frederick Smith & Co.

Quotations supplied by { f India-Rubber, G.-P. and Teleg. Works g Messrs. James & Shakspeare. [Co., Ltd. h Messrs. Jackson & Till. i Messrs. Bolling & Lowe. j Messrs. Henry C. Yeo & Co.

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INSTITUTION OF ELECTRICAL ENGINEERS (GLASGOW SECTION).

NOTES ON SOME SYSTEMS OF LAYING UNDERGROUND CABLES.

By Arthur Devey.

(*Abstract of Paper read March 13th*, 1901.)

(*Concluded from page* 606.)

In London, for the new telephone system, the Post Office are using glazed octagonal earthenware ducts, laid in concrete and cement; they are made in two lengths, namely, 18 and 24 in., and are 3¼ in. internal diameter, the short ones being used for entering the man-holes.

The method of laying is as follows:—A bed of concrete 6 in. thick is first laid, then a layer of cement ½ in. thick, then a tier of ducts, then another layer of cement ½ in. thick, and so on, all interstices between the ducts being filled up with cement. When all the tiers are laid, the sides and top are covered with concrete about 6 in. thick. They are laid at a minimum depth of 3 ft. from the top of the concrete to the surface of the road. These ducts are very largely used in the States, and apparently have given satisfaction there.

The boxes are of 14 in. brick work and usually 8 ft. long, with varying widths according to the number of ducts entering them. Cast-iron pipes are used for crossing roads and for distributions.

The Brooks semi-solid system consists of lap-welded wrought-iron tubes about 15 in. long, they are connected together by an ordinary screw socket, every other length is connected together by means of a tee coupling closed at the top with an ordinary plug; these are necessary for filling the pipes with the semi-solid oil, which becomes liquid at about 300° F., and when cold is similar in consistency to india-rubber solution.

It is important that the cables and the interior of the tubes should be absolutely free from moisture, and that all joints should be thoroughly tight.

The cables used with this system are not lead-covered; the insulation is of strong fibrous material, which gets impregnated with the oil used for filling the pipes.

Any system of conduits of which the various units are only of short lengths, is always very liable to get damaged through the ground sinking underneath it; this can of course be guarded against by concreting the bottom of the trench first, but naturally at a very much enhanced cost.

All pipes on conduit systems should be properly ratted before any cable is drawn in, and a matter of great importance is the placing of the drum of cable over the drawing-in hole, so that the cable shall be fed in without any possibility of kinks or strains arising; at the drawing-out hole jockey pulleys are required to prevent the rope or chain chafing. A chain is usually preferable to a rope; it lasts much longer, and it requires less power. A chain also does not stretch like a rope, so that the cable comes along at a steady rate, and not in jerks. Petroleum jelly should be used for greasing the cables; this is much better than soft soap, and is but little more expensive. The cables for drawing into pipes should preferably be juted, or at least braided, as the lead is thereby protected from accidental damage. The clips for attaching the cable to the hauling rope or chain are of various kinds, according to the different kinds of cable. As regards winches, when an ordinary plain barrel one is used, the rope always rides up to one end, necessitating stopping every few minutes and slacking out the rope to allow it to be got back to its proper place. A grooved barrel winch has been made to do away with this inconvenience, and has been found to work perfectly with either a rope or a chain.

The third system, known as the "solid" system, seems to be the chief favourite for the moment, although it is curious to note that the Yankees consider it absolutely antiquated and out of date, they pinning their faith to conduit systems. Its advantages are its flexibility—a great desideratum in large towns, where pipes of all sorts are so numerous—combined with at least as good mechanical protection as iron pipes, whilst there is no danger to be feared from gas. The system is that of a cable laid centrally in a three-sided trough—**V** troughs have been occasionally used, but are not to be recommended. The trough, which may be of iron, earthenware, or wood, is then filled up solid with bitumen; a cover is placed on top, and the whole thing buried. There should never be more than one cable in each trough, and troughs should never be laid one on top of another.

As the dangerous part is the cover, the use of iron troughs appears to be hardly necessary, except when required to comply with the Board of Trade regulations. They are expensive, if light are fragile, and if heavy are troublesome to handle.

When laying solid systems in wet weather, care should be taken that the troughs and cables are kept dry until the bitumen is run in and set, as drops of water cause blow-holes in the bitumen, with the result that it is not homogeneous.

It is advisable to use juted or braided cables in all cases in preference to plain lead-covered ones, whether for drawing into a pipe or conduit system or for laying on the solid system; the extra cost is not much and it is certainly worth it, owing to the protection the jute or braiding gives to the lead against mechanical damage. In one town in England, double juted cables have been drawn into a pipe system, and even armoured cables have been at times drawn into them.

Probably the best system would be armoured cable laid solid in wood troughs, with a minimum thickness of bitumen of 1 in. all round, the troughs and covers to be of 1 in. thickness also; if wiped lead sleeves are used for the joints they should be enclosed in cast-iron troughs with cast-iron covers, both enclosed in a wood trough with a wood cover, so that there would be continuous metallic armour and continuous wood trough from end to end. The cast-iron troughs and lids should be bonded to the armour of the cable, and if boxes are used they should be of the compound gland type, also bonded to the armour, which should be taken inside the glands. Such a system would be expensive, but it should be a guarantee against damage of all kinds, whether mechanical or electrical, and therefore would prove cheapest in the long run.

Before the commencement of the discussion the Chairman called upon the secretary to read two communications which had been received from Mr. H. Mavor and Mr. W. W. Lackie.

Mr. Henry Mavor, member, communicated: I have read Mr. Arthur Devey's paper, which appears to be principally a historical account of what has been done, with an expression of preference for armoured cable laid solid in wood troughs with bitumen. This is a fairly satisfactory way of dealing with cables in places where there is not a very substantial road bed, but where the access to such a cable involves lifting well-laid granite setts on a layer of concrete, the disturbance to the streets for the manipulation of these cables for joints, &c., is a very serious disadvantage. It is disappointing to note that Mr. Devey does not advocate the only really satisfactory way of dealing with the question in cities, viz., the provision of thoroughly adequate conduits, to which access can be obtained from end to end. The extra cost of these conduits as compared with the present methods is not such as to prohibit their use, and most city engineers are agreed that they ought to be provided not only for electric light and power, telephone and telegraph cables, but also for gas, water, hydraulic power, pneumatic tubes, &c. The provision of such a conduit artificially and well ventilated is the only practical solution of the question, and one which also solves the problem of underground conductors for electric street railways. I had an opportunity recently of talking the matter over with the engineer who is in charge of the most important streets in the world. He is thoroughly convinced that the only proper way to deal with the question is to proceed at once to make conduits providing entirely new systems of supply for all the above-mentioned public requirements, leaving the present arrangements intact until their work can be done by the new arrangements. This involves an enormous expense, but does the work once for all, and would probably be the cheapest method in the long run. We have had a sufficient object lesson on the disadvantage of all the present systems in Glasgow during the last five years to warrant us in looking for a drastic remedy, and in adopting such a remedy, even at a very great capital cost.

Mr. W. W. Lackie, member, communicated the following: My only regret in connection with Mr. Devey's paper is that he has not in the end given us anything definite, or expressed his own opinion on any one particular system of mains. It may be, however, that he infers that no hard and fast rule can be laid down. Considering that mains represent from one-third to one-half of the capital expenditure on electric lighting installations, it is of great importance that they should be properly laid, as very often "out of sight out of mind" is true in this matter. Referring to Mr. Devey's paper, I do not see that it means keeping a larger stock of cable in hand with a draw-in system than with a solid system, neither is it necessary to make two joints with a draw-in system. I admire the manner in which Mr. Devey states that it is a simple matter to open the ground where the trouble has occurred. The trouble is, of course, to find the place to open, which often necessitates digging up 10 or 12 yards of the street in a solid system, whereas in a draw-in system the two nearest joint boxes can be opened and the cables drawn out of the pipes. Personally, I believe that no hard and fast rule can be laid down for laying mains. In outlying and country districts lead-covered and armoured cables, laid direct in the ground, with a tarred board over them, appear to be the cheapest, and answer the purpose perfectly. In a city, where there are likely to be tramways and stray currents, it is necessary to adopt a solid system of some kind, with the cable run in partially insulated troughs, but I also think there are places where a draw-in system would pay, as the cost of opening the street to remove or repair a fault comes to be very heavy where the streets are laid with concrete and wooden blocks.

Mr. W. B. Sayers, member, in opening the discussion, said that he did not propose to occupy their time in discussing the various systems of laying mains. There were one or two points, however, to which he would refer. Mr. Devey spoke of getting rid of the gas mains from the streets. Mr. Sayers did not think there was any prospect of this. The increase in the revenue of the London gas companies from 1896 to 1898 amounted to over £3,000,000, and their profits for one year to £1,611,000. The latter sum was just about equal to the total revenue of the electricity supply companies of this country. Another point was that as soon as ever the gas supply companies began to feel the pressure of the electricity companies in competition, there could be very little doubt that they would start a heating supply, and he was afraid that what they would have to look forward to was not the removal of the gas mains, but the duplication of them. It seems a most clumsy method of going to work, each going his own way and adding to the tangle, and one felt that this matter of main laying ought to be dealt with in some methodical fashion. Another point that he would like to ask Mr. Devey about was the question of electrolysis.

In several parts of the paper Mr. Devey had spoken of bonding round junction boxes, &c., and he would like to have something definite from Mr. Devey on this question of damage from electrolysis. The speaker believed Mr. Chamen had had some difficulties in this connection, but he would like Mr. Devey to give them examples of damage which were actually due to electrolysis.

Mr. Wm. McWhirter, member, said: Referring to the remark *re* cables laid at Bray, it would add considerably to the value of the author's statement were he to give the date when the cables referred to were actually laid. I have already in this room freely expressed my opinion of cables depending entirely upon the lead covering for their duration, and although the use of such cables in wood conduits whereby they can be entirely surrounded by bitumen is a step in the right direction, and must in a considerable degree protect the lead from the corrosive influence, yet I maintain that such cables are far from being permanent. Wood troughs as stated must have some preservative applied, otherwise their life is very short. No doubt creosote would give almost perfect protection against decay, but I am not so sure how far it would increase or diminish the life of the lead cables. I remember many years ago laying a long length of gutta-percha covered telegraph wire, and also a considerable quantity of vulcanised india-rubber cable in creosoted wood troughs, and I regret to say that in less than a year these cables had all to be removed and replaced by others with gutta-percha insulation laid in similar wood troughs, but on this occasion the troughs had been impregnated with boiling Stockholm tar. These cables, so long as they were under my care, remained in perfect order, and gave absolutely no trouble. The troughs were made of a **V**-shape, 1 in. thick, a board being laid on the top, not, however, nailed, as suggested by Mr. Devey, as experience had before this shown that, no matter how carefully nailing was carried out, some nails were sure to find their way through the wood amongst the cables, and in course of time gave no end of trouble. At distances apart of 2 ft. the covers were secured by means of a short length of galvanised iron wire simply passed round the troughs, the ends being twisted securely. Notwithstanding the strong preference the author shows for solid systems, in my opinion the time must soon come when such an arrangement will be adopted as is mentioned in Mr. Mavor's communication, viz., a proper built conduit, where all such cables, including telegraph and telephone, can be securely laid; and although this must of necessity entail a large capital expenditure, yet in the end it will be money well spent. As against the drawing-in system the author claims for the solid system more speedy repairs in damaged cable, &c., stating that it is simply necessary to open out the ground at the place where the fault has occurred and have the fault made good. Might I ask what system of localisation the author proposes using which would enable him to so readily find the spot where the fault exists? I have often carried out loop tests on telegraph lines, and such tests have impressed very strongly upon my mind the difficulties which must exist in exactly locating a fault in heavy copper cables. The advice given about manholes is, I believe, correct. These should certainly be large and roomy, and I am pleased to be able to congratulate Mr. Chamen on the splendid work he is doing in this direction through the introduction of his cast-iron manholes. Too much stress cannot be laid upon the necessity for great care in examining the interior of iron pipes, as any defect in this portion of the system will speedily call attention to such neglect. Were it possible to use the Brooks semi-solid system, keeping the pipes thoroughly filled with oil and preventing any leakage, I believe we would have something almost ideal. The new fibre pipes now being introduced I am afraid are not of a nature to give confidence to anyone who has had experience in the various bitumenised paper conduits which have been in use for the last few years. I have never found moisture fail to destroy these conduits very rapidly, and anyone who has had occasion to use fibre to any extent must be aware how readily it is affected by damp. My advice would be—Leave all such material severely alone so far as placing underground is concerned.

Mr. E. George Tidd, member, said that in the first place there had been one or two allusions to the Brooks system of mains; it was often very much more difficult to get the oil into the pipes than to get it out. He had himself some years ago had occasion to lay down a system of mains for the lighting of the Glasgow Harbour tunnels, and he had selected the Brooks system on account of the amount of water about. The mains were all carried from the south side shaft, where the plant was, to the north side shaft, and the greatest difficulty was found in getting the oil to flow down to the centre of the pipes; the temptation was given way to of thinning down the oil so as to make it flow more easily, but the consequence was that the oil was found to leak at some of the joints. However, on the whole, the installation had been very successful, and he believed that it was working quite satisfactorily at the present time, and that there had been no breakdowns. With regard to the question of draw-in *versus* solid systems it seemed to him that there was not the slightest use in a draw-in system, for distributors at any rate, because it would be quite impossible to draw out a length without opening the ground at every connection and cutting the joints, and he would scarcely think that the advocates of draw-in systems would go so far as to propose a manhole and joint box for each consumer. With regard to the references to pump log ducts, Mr. Devey mentioned that they were very cheap where timber was cheap, but he would think that the labour in boring out a 3-in. hole through a log of timber would be a very expensive matter. He further asked Mr. Devey if in stating that in the solid system not more than one cable should be laid in the same trough, he referred to concentric cables, or whether he included cases where single cables were used, as it was a very common practice to put three single cables in the same trough as had been seen on the photographs shown on the screen. Mr. Devey also suggested the use of nails for nailing on the lids of the troughs. There was rather a risk entailed in this, as the average British navvy would not be over particular as to whether he drove the nail into the trough or into the cable.

Mr. J. C. A. Ward, associate, said that he would like Mr. Devey to explain what was meant by taking the armouring of the cable into glands of the joint boxes. He presumed that by armoured cable Mr. Devey meant cable with a lead sheath and an armoured taping, and it seemed to him that if the steel taping was taken into the glands of the boxes (the glands being designed with a view to make the boxes water-tight) the moisture would follow. Mr. Devey also referred to the bonding of the steel sheathing of cables on to the joint boxes. If the steel sheathing was trimmed off outside the joint box it would be necessary to thoroughly bond it to the lead, as his experience had been that arcs very often took place between the lead of the cable and the steel sheathing at points where the steel sheathing terminated, owing to the fact that the jute or tape put on between the lead sheathing of the cable and the steel tape practically insulated the lead from the steel sheathing except where the latter terminated, and at this point the steel sheathing might be half in contact with the lead, or moisture being more easily able to saturate the jute, would start electrolysis or arcing if the lead sheathing became alive. Regarding draw-in systems, he considered that before deciding on such a system it would be well to consider the class of work for which it would be required. His opinion was that it was not a suitable system to be used for distributing mains, for the reason that the numerous **T** joints in such mains did away with the advantage of being able to draw the cable. Another disadvantageous point in a draw-in system was the number of draw-in boxes required, and also the risk of gas. He had had experience of air circulation, and did not consider it a workable scheme. Referring to Mr. Devey's remarks on the Glasgow Corporation electric lighting department's cast-iron chambers, taking everything into consideration, he did not think the cost would work out very much higher than brick or concrete pits of the same dimensions if used for the same purpose. Cast-iron chambers could very quickly be erected, took up far less space than brick pits, and, moreover, were gas and water-tight. They also formed excellent earth plates. In calculating the cost of brick pits to be used in a similar manner, the cost of an earth plate should be added, as also the cost of a special lining of asphalt at the bottom and also between different sections of the brickwork, this being the only means by which the box could be kept free from gas and water. He did not consider it desirable that man-hole covers should be locked except in the case of high tension mains, where, of course, every precaution was absolutely necessary. He considered that there was a great opening for designs and arrangements in the street disconnecting points, which would facilitate the manipulation of sections of the mains in a very short space of time. Anything designed with a view to doing away with spanners and tools of every description when breakdowns occurred would be of great advantage. Besides, if covers are not locked, in the event of a gas explosion in the chamber the cover alone is lifted, and this is preferable to the cover taking a portion of the street with it. Regarding the jointing of cast-iron pipes where rubber or V.B. sheathed cables are drawn into them, it did not seem desirable to go to the expense of lead-caulked joints, as however carefully the joints were made, it was his experience that water always accumulated in some portion of the pipes. It may have been due to the joints becoming leaky or to condensation, but the fact remained that he had never seen a system of pipes in which there was not some water. Therefore, unless the cast-iron pipes required bonding for purposes of preventing electrolysis or protecting lead-covered cables, it seemed to be an unnecessary expense. The question of electrolysis was one which could hardly be gone into at that meeting, as it was a subject which would involve much discussion. The speaker, however, felt sure that those engineers who had adopted the method of not keeping the lead covering of cables metallically connected throughout, but had broken the lead at every 150 yards or so, were making a serious mistake. Doulton ware was a most excellent conduit, but it required a certain amount of skilled labour and considerable skill in working the mandrels under circumstances where bends or sets out of the straight were required. Pump log ducts were very durable, in fact, the most durable form of duct that could probably be obtained; but great difficulty would be experienced in using them for a system which required a considerable amount of jointing. Brooks's semi-solid system was an excellent one if the joints could be kept tight, but if the water happened to get at any of the joints and a fault occurred on the mains it was rather troublesome to rectify. The speaker did not consider that lead-covered cables should be braided if laid on the solid system, for the reason that if the braided cables were stored in the open for any length of time, the braiding would become saturated with moisture, which being dispelled when the hot bitumen was poured into the troughs, would cause the bitumen to become porous.

The Chairman (Mr. W. A. Chamen) said that in draw-in systems it seemed to him that ½ in. clear in the bore of the pipe above the outside diameter of the cable was not always a sufficient clearance, but that the rule should be some percentage of the diameter of the cable, as very large cables were stiff and unwieldy and would probably require more clearance than small ones. He also thought that another objection to jute braiding the outside of lead-covered cables when being laid on the solid system, was that it prevented defects or injuries in the lead from being observed at the time of laying. Referring to the question of electrolysis, he pointed out that the use of concentric cables as in Glasgow should reduce this trouble to a minimum. The cables were all triple concentric, having the neutral conductor outermost, and next to the lead. The neutral conductor being maintained at earth potential by means of

an earth connection at the generating station, it was clear that any injury to the cable should result in first making contact between the lead and this neutral or earthed conductor which would be harmless. In this respect the system worked perfectly, but experience had proved that in spite of all it was possible for the lead to be made alive from positive or negative conductors by troubles arising at the end connections. He did not propose to enlarge upon the subject of end connections. They were a completely separate study in themselves, and were capable of giving an immense amount of trouble. It did not seem to matter much in regard to them whether the cables were concentric or single ones. The same trouble arose in both cases. Allusion had been made to the Brooks system with oil insulation, and he would like to point out that the trouble with it appeared to be to keep the oil securely sealed up within the pipes. Of course they all knew that the trouble with other systems was to keep the water out, and it was a remarkable fact that no matter which system was adopted, the design in practice sometimes failed to perform its object. That is to say, while in one case it was found difficult to keep the oil in, in the other case it was found as difficult to keep the water out. He was quite in agreement with Mr. McWhirter in his view that the gas mains would not disappear from the subsoil, and was convinced that in the future gas engines would take the place of steam engines, but the difficulty at the present time was to get sufficiently good gas engines in large enough sizes for the purpose of generating electricity in large quantities. He had heard that Mr. Westinghouse was engaged in elaborating a scheme by which gas would be made at convenient spots and forced under pressure to sub-stations, where the pressure would be reduced and the gas consumed in gas engines driving dynamos. He thought there was a great future for a system of this kind, and sincerely hoped that Mr. Westinghouse would succeed in producing a satisfactory gas engine, which he certainly could not say was to be found upon the open market to-day. It was a notable fact that the Glasgow Corporation along with others were seeking powers to reduce the illuminating power of gas. This, of course, was a step in the direction of cheapening gas supply for cooking and for driving gas engines, while doubtless it would have some bearing upon the question of incandescent gas mantle illumination which was being boomed so much at present. In view, therefore, of all these considerations it did not seem likely that gas pipes would disappear from beneath our streets and leave any more room for electric mains than was found at present. There was one system of mains which had not been mentioned by Mr. Devey in his paper nor by any of the speakers in the discussion, and that was the bare copper strip system. There was no doubt whatever in his opinion that it was an extremely good system, and much easier and cheaper to maintain when properly laid than any other system. No doubt the members present were fully aware that there was a large quantity of bare copper strip in use in the city of Glasgow, and he was pleased to be able to tell them that for some two years past he had had a section of mains of this kind carrying a supply of 500 volts pressure, and that it had never given one moment's trouble under these conditions. The Glasgow conduit was a cast-iron one of a rather too shallow form, and the conductors, particularly when there were three or four strips piled one on top of another, were in too close proximity to the cast-iron roof. The conductors were not stretched, but were supported on insulators some 6 ft. apart, and while precautions had been taken to prevent the strips sagging downwards and touching the bottom of the culvert, the fact had apparently been overlooked that they might buckle upwards and touch the roof. This, unfortunately, was what they did when expanded to a slight extent through a small rise in temperature, which occurred owing to the amount of current passing through them at times of full load. This difficulty, however, would not occur when in use on a 500-volt supply, as the current density could be kept so very much lower, and there would be practically no warping effect at all to cause trouble. A most interesting point in the Glasgow system was that what was known as the "sodium" trouble—namely, the accumulation, like a growth of fungus, of sodium upon the insulators round the negative conductor—appears to be entirely absent. This was, no doubt, caused by the fact that as the conduits were formed of cast-iron, there was no cement or other material from which sodium could be extracted. Altogether the results of the two years' trial of the bare copper strip had been so satisfactory that he had decided to convert more of the old mains in the same way. It was very interesting to know that in Edinburgh, where the culverts were made of concrete, the sodium trouble was considerable, particularly after the increase of pressure, but the arrangement of mains had been altered by the utilisation of the Crompton system, in which the conductors were tightly strained up in a thoroughly mechanical and substantial manner, doing away altogether with the greater portion of the insulators which were used with the other system, and allowing the use of special insulators of a kind particularly adapted for preventing leakage. The results since the alteration had been entirely satisfactory, and he had often wished to use this system in Glasgow, but owing to the impossibility of constructing long runs of culvert beneath the footway, he had been compelled to give up the idea, as the construction of culverts beneath roadways was very expensive and undesirable. The question of constructing large underground tunnels, after the manner of the Paris sewers, had been touched upon, and it was a very fascinating idea. The engineers of other departments, however, held very varying views about the proposal. The gas engineer objected that the tunnel might become accidentally filled with a highly dangerous explosive mixture of gas and air, and the water engineer pointed out that in the case of a large water main bursting—an accident which would happen occasionally, in spite of all precautions—matters would be in a serious state inside the tunnel. There was also the question as to how access was to be provided for such unhandy articles as 9 ft. or 12 ft. lengths of cast-iron pipes 4 ft. in diameter, and whether the tunnel was to be sufficiently large to accommodate a railway for the purpose of conveying such goods for repairs, &c.

Mr. Devey, in reply, said that he regretted he could not agree with Mr. Mavor as regards subways. He thought Mr. Chamen's view was the right one, viz., that subways as usually understood were quite impracticable from an engineering point of view, the question of their cost being put on one side altogether. A subway in the centre of a street would be exceedingly troublesome as regards the distribution question, and as pointed out by Mr. Chamen, it would be exceedingly dangerous to have large gas and water mains in it. Distributors, whatever they were, should be kept quite separate from the feeders, and they should necessarily be as close as possible to the place supplied. Their natural place was, therefore, under the footways, and if a sort of concrete duct were built extending from the house line to the kerb, all distributors could be placed in it. This duct need not be more than 12 in. or 15 in. deep and should be covered by ordinary flags; every flag should be capable of being lifted by suitable keys, and the flags could be carried by ordinary ⊥-irons. The duct would necessarily be connected to the sewer to drain off rain water, &c. If the distributors were thus arranged, there remained the feeders to be dealt with. Now these, if properly laid, should never require the least attention; they can, therefore, be buried under the roadway, thus doing away with the necessity of an immensely costly and dangerous subway. As regards the question of gas pipes disappearing, raised by Mr. Sayers, he was hoping that they would get electric heating, which, no doubt, would be aided materially if gas were used for motive power as mentioned by Mr. McWhirter. The question of electrolysis was a very great one indeed, and would require a paper to itself. It was not possible to treat it in little bits. As regards Mr. Lackie's remarks that a fault on a pipe system was easier to get rid of than one on a solid system, the author thought that anybody with a little care should be able to locate a fault on the latter system practically on the top of it; he therefore regretted that he could not agree with Mr. Lackie, especially as he considered that a fault should never occur on a properly laid solid system. Mr. Ward seemed to have some doubt as to the feasibility of taking the armour of armoured cables inside the glands of boxes, but he could assure him that no trouble as regards water arose from doing so. Mr. Ward also mentioned the possibility of arcing arising in the case of lead-covered cables laid in iron troughs. This was a very real danger, and it was absolutely essential that the troughs should be thoroughly well bonded together. In conclusion, the author said that his paper was only intended to create a discussion so that new ideas could be produced. He was exceedingly obliged to Mr. Chamen for calling his attention to the system of threddling pipes on to cables instead of drawing the cables into the pipes in the old-fashioned way. He had no doubt that that was a great improvement. He tendered his thanks to the chairman and the members for the kind way in which they had received his notes.

INSTITUTION OF ELECTRICAL ENGINEERS (MANCHESTER SECTION).

Dr. E. Hopkinson presided at the last meeting of the Manchester Section of the Institution of Electrical Engineers, which was held in the new physical laboratory at Owens College. The business of the evening was a paper by Prof. Sidney H. Short on "Direct Current Generators." After the minutes of the previous meeting had been read, the chairman called upon Mr. Short to read his paper.

Mr. Short then read the following paper, using a series of diagrams shown on a screen by the electric light to illustrate it:—

DIRECT CURRENT GENERATORS.

By Sidney H. Short.

(*Abstract of paper read March 26th*, 1901.)

Clark, who was the first to put into execution Faraday's great discovery of induction, used permanent magnets for the field, and an armature core provided with projections, each projection being wound with a coil of insulated wire, the ends of which were connected to commutator bars in the usual way.

Gramme, on the other hand, used a ring of soft iron wire for an armature core, the coils of insulated wire being wound spirally around the section of the ring, with branches at intervals leading to the commutator. This form is known as the Gramme ring, and for many years was a favourite with generator designers, but is fast going out of use.

Early in the history of dynamo construction, Siemens devised the well-known drum winding, the coils of insulated wire being wound lengthwise and over the ends of a cylindrical armature core, with their terminals joined to the commutator strips. This winding, in an improved form, is now coming into general use, and promises to be the final one.

All of the earlier machines were bipolar, with their armatures revolving, at a high rate of speed, between the two poles of a single U-shaped magnet.

When the commercial value of the dynamo became apparent as a source of power for electric lighting, for operating motors, and for the many uses to which large electric currents are put, there sprang up a demand for machines of larger and larger capacity. The two-pole machines were increased in capacity until a limit of distortion

was reached where it was found impracticable to further augment their dimensions.

The next step, therefore, was the adoption of the multipolar type. In these machines there are two or more magnetic circuits formed in the same core, by arranging two or more pairs of field magnets around the periphery of the armature.

You are familiar with the advantages of this type of machine. A four-pole machine containing the same quantity of active material as two bipolar dynamos will have their combined output at half their speed.

The ease with which these machines can be ventilated, owing to the large internal diameter of the armature, makes them run much cooler than the bipolar type. The arrangement of a number of sets of brushes around the periphery of the commutator permits the use of very short bars, rendering the mechanical construction most perfect.

As direct-driven slow speed generators having many poles are usually specified for our modern power stations, you will be interested in the details of their construction.

* The magnet frame is a ring of large diameter, usually with a rectangular section, having two feet or brackets cast integral with it, to support it in a vertical plane upon a masonry foundation. The width of the face and the cross-section of this frame do not differ very greatly in machines of different speeds and capacities, except for the very small ones, but the diameter depends on the capacity and number of poles.

Some makers prefer to cast this frame in iron, others in steel; each has its advantages and disadvantages. On the whole, I prefer the cast-iron frame, because, while it is nearly twice as heavy as the steel one, it is more rigid, and costs less. However, when very large machines are required to be shipped to great distances, it is necessary to use the steel castings, because of the smaller weight.

The frame is always divided into two half rings, with finished joints, where they are bolted together. This division is usually on the horizontal plane, but one or two makers divide the ring vertically.

On the inner periphery of the magnet frame at intervals are fastened an even number of pole-pieces, projecting radially towards the centre. These pole-pieces are always made of good soft steel, sometimes rectangular in section and sometimes round. The area of the cross-section is about equal to that of a cast-iron yoke, but considerably greater than that of a steel yoke. The radial length of these poles, which does not vary greatly with the capacity of the machine, is from 12 in. to 15 in. When the frame is made of cast-iron, these pole-pieces are composed of steel plates rivetted together to make a nearly square section, and cast into the ring in the proper positions.

If the frame is made of cast-steel this method of attaching the poles cannot be advantageously used, but they must be bolted to finished surfaces, prepared for them, on the inner surface of the magnet ring, which is a much more expensive process.

I must not neglect to explain, however, that when the pole-pieces are bolted to the steel frame they may be cast in steel, with a round section, and provided with a suitable pole-shoe to fit the armature face, while with the laminated pole the shoe must be fitted to its inner end. On the whole, however, the laminated pole cast in the frame is cheapest, and lends itself to ease of manufacture.

The pole-pieces are provided with spools, upon which are wound the magnet coils. These coils are connected in series, and the exciting current traversing them produces alternate positive and negative poles at their free ends.

This completes the essential parts of the stationary portion or field magnet of a multipolar generator. We will next turn our attention to the construction of the armature, with its commutator, which we will find more intricate.

The engine shaft carries, besides its fly-wheel, a massive cast-iron armature hub, keyed to it securely. This hub is provided at its periphery with a flange bolted to the fly-wheel, thus relieving the shaft and keys from the torsional strain due to the interchange of energy between them.

The armature hub is provided with a number of radiating arms, the ends of which are dovetailed parallel with the shaft for a length equal to the width of the pole-pieces. Into these dovetailed grooves are fitted the key-pieces formed on the inner edges of the armature laminations.

The laminations which form the magnetic portion of the armature ring are made from thin sheet steel of the softest quality. They are in the form of segments of a circle, with notches in the outer edges. These segments are built on to the ends of the spokes of the armature hub, lapping joints, until a complete rim or core is formed equal to the width of the pole-faces. Occasional radial ducts are left so that the air may circulate freely through the core, to carry away the heat produced by hysteresis and eddy currents.

This mass of thin sheet segments is clamped firmly between two end rings of cast-iron, held together by bolts passing between them just inside the lamination. The notches in the edges of the sheets register perfectly, so that slots are formed across the face of the armature to receive the armature windings.

An extension of the armature hub carries the commutator support, which is much like an ordinary spoked pulley. At each end of its face, clamping rings are provided to secure the commutator bars. These strips are hard drawn copper of the best quality, and should have a width at the face of the commutator of at least one-third of an inch. The mica which separates them should never exceed $\frac{1}{32}$ in. and must be of a very soft quality, so that it will wear more easily than the copper. The bars are bevelled or notched at the ends to receive the mica insulating and clamping rings, which secure them to the face of the hub.

The commutator is always smaller in diameter than the armature core. In fact it must not have a peripheral speed of more than 2,500 or 2,600 ft. per minute. With higher surface speeds it is difficult to prevent sparking.

To each bar at the end nearest to the armature core is rivetted and soldered a copper strip, projecting radially to the same diameter as the armature core, where it connects with the ends of the armature coils.

The armature coils are simple in construction. Ribbon copper, usually $\frac{1}{2}$-in. by $\frac{1}{10}$-in., is cut into pieces long enough to make a complete coil. This strip is bent on edge in the middle, making the two halves parallel with each other and about $\frac{1}{2}$ in. apart; it is then bent flatwise around a former into a rectangular coil, with V-shaped ends joining the two parallel sides, the angle of the V at one end being formed by the terminals of the coil, which are afterwards soldered to the commutator leads. The coils are carefully taped with combination insulation made from paper, mica, and linen webbing. They are saturated with insulating compound, and baked before being placed in the armature slots.

The coils span a segment of the periphery of the armature core, equal to or slightly less than the pitch of one pole, one of the parallel sides being fitted into the bottom of a slot, while the other side occupies the top of another slot; two and sometimes more of these coils are placed side by side in the same slot, but it is not best to multiply the number.

These coils overlap each other, making a closed circuit spiral winding around the face of the armature with each turn connected to a commutator bar.

After the winding is completed the coils are held in place by binding wires at intervals across the face of the core.

The windings are connected to balancing rings placed conveniently between the armature core and commutator, each ring connecting at points of equal potential, ensuring uniform pressure between all the units making up the multipolar machine.

It only remains to provide a support for the brushes which collect the current from the face of the commutator. Four brackets are bolted to the end of the frame, and in these the brush rocker rotates through a limited angle. This rocker carries a brush holder and set of carbon brushes for each pole piece. They are carefully insulated from the rocker and from each other, but all the positive brush holders are connected to one massive ring, and all the negative holders to another. These cross connecting rings form the terminals of the generator from which the leads pass to the working circuit.

The mechanical construction of direct current generators has, as you can see, been very well developed, and there remain apparently very few improvements to be made in it. We will, therefore, have to look in other directions for changes which will improve their operation and diminish the cost of their manufacture.

Until recently multipolar generators were constructed with a limited number of poles, and to accommodate them to the various speeds and increasing capacities required, their proportions were distorted, as in the bipolar machines, with the unfortunate consequences always attendant on poor design.

Recent machines are being built with an increasing number of poles, and generators of 1,000 KW. with 14 poles, 1,600 KW. with 16, and 3,000 KW. with 24, are in successful operation with speeds ranging from 75 r.p.m. for the larger size to 90 revolutions for the smaller.

It is apparent that modern design is tending to a greater number of magnets in the direct current generator, and it is interesting to see that on the other hand the modern alternating current machine is being made with fewer and fewer poles.

The frequency in modern direct current generators is about 15 cycles per second, while in alternators for power transmission the frequency is as low as 25 cycles per second.

Even in the mechanical construction and general appearance these two classes of machines are approaching each other, with this difference, that for the direct current the armature must revolve to carry on the process of commutation, while in the alternator the field magnets are made to revolve.

How far are these changes in design to be carried, and what are the causes acting to bring them about?

Experience has taught us that there are certain mechanical, electrical and magnetic values, which, when strictly adhered to in the design of direct current generators, produce the best working results.

We will apply the best average working values to a unit dynamo with one pair of poles, and for greater capacities add two or more of these units together in the form of multipolar machines to determine the best relation between speeds and capacities. The capacities of these machines thus made from unit dynamos will be fixed, depending on the capacity of the unit and the number of these units used in its design. The speeds of these machines will also be established, as we have in the unit dynamo adopted certain values depending upon speed.

I have taken for the unit dynamo a surface speed of 3,300 ft. per minute for the armature.

For the commutator a peripheral speed of 2,500 ft. per minute.

The teeth on the face of the armature have a pitch of 1 in.

The commutator bars (550-volt generator) are ·377 in. wide, and the pressure between them is 10 volts.

Every inch of the periphery of the armature face carries at full load 500 amperes.

10·3 million magnetic lines pass through the magnetic circuit in this unit dynamo.

* This description will necessarily be general, in the manuscript, because of the absence of the illustrations.

The density in the poles at full load is fixed at 95,000 lines per square inch, in the air it is 80,000, while in the teeth it reaches 120,000 lines. In the armature core the flux is reduced to 65,000 lines per square inch.

A fair average frequency for direct current generators is 1,600 alternations, or 800 cycles per minute, therefore this unit must run when made into a bipolar machine at 800 r.p.m. and deliver 137½ KW.

The performance of this machine will in every way be good, for the various values taken are those most satisfactory.

Without making any changes in the dimensions of the parts or in the electrical and magnetic values, we will put two of these units together in the form of a multipolar generator. There will now be four poles, but they will have the same section and the same magnet spools. The armature will be doubled in circumference, also the slots and armature coils, commutator bars, brushes, brush-holders, and various other parts, all being inter-changeable with those of the unit machine. This four-pole machine will deliver 275 KW., and the speed will be 400 r.p.m.

Applying these unit dynamos in the construction of an eight-pole machine, we find that it runs at 200 r.p.m. and has an output of 550 KW. A 10-pole machine will run at 160 r.p.m. and deliver 687 KW.

The following table gives the speeds, capacities and general dimensions of machines up to 30 poles, and in all of them we have not varied from our original data established for the unit dynamo.

UNIT DYNAMO-ELECTRIC MACHINE.

Mechanical Data.		*Magnet Data.*	
Pole pitch	25 in.	Induction air ...	80,000 L.
Periph. speed arm. ...	3,300 ft.	„ teeth ...	120,000 „
Tooth space	1 in.	„ arm. ...	65,000 „
Periph. speed com. ...	2,500 ft.	„ poles ...	95,000 „
Thickness bar ...	·377 in.	„ yoke ...	35,000 „
Section pole-piece ...	125 sq. in.	Alt. per min. =	1,600
„ yoke ...	150 sq. in.		

Electrical Data.

KW. capacity...	137
Amps. per inductor...	125
Volts per bar	10
Pressure of machine	550 V.

Poles.	R.P.M.	Amp.	KW.	Arm. Dia. Feet.	Com. Dia. Feet.	KW. /100 Revs.
2	800	250	137½	1·3	1·0	17·2
4	400	500	275	2·7	2 0	68·8
6	267	750	412½	4·0	3 0	154
8	200	1,000	550	5·3	4·0	275
10	160	1,250	687½	6·7	5·0	430
12	133	1,500	825	7·9	6·0	619
14	114	1,750	962½	9·2	7·0	844
16	100	2,000	1,100	10·6	8·0	1,100
18	90	2,250	1,237½	11·9	9·0	1,375
20	80	2,500	1,375	13·2	10·0	1,720
22	73	2,750	1,512½	14·6	10·9	2,070
24	67	3,000	1,650	15·9	11·9	2,460
26	61	3,250	1,787½	17·3	12·9	2,930
28	57	3,500	1,925	18·6	13·9	3,380
30	53	3,750	2,062½	19·9	14·9	3,820

A study of this table reveals the fact that when we have established certain running values to be used in the construction of multipolar generators, we must let the speed of the machine depend upon the output. In making up this table of speeds the unit dynamo adopted works out well for capacities up to 1,000 or 1,200 KW. For the larger machines, however, it is possible to load the armature with 600 or even 700 amperes per inch of periphery, thus lowering the number of poles, decreasing the diameter of the armature, and increasing the speed. A considerable variation of speed for a given output may be secured by varying the section of the magnetic circuits of the unit dynamo and the number used; the range through which this change in speed can be made is, however, limited.

The advantages of a standard system of design as outlined here will be appreciated by manufacturers as well as by users of electrical apparatus, because of the interchangeability of parts and the certainty of uniformly perfect operation of every machine regardless of capacity.

In all sizes of machines the same size pole-piece would be used. The magnet spools would all be interchangeable. The armature coils would all be alike. The brushes, brush-holders, and all the connecting parts would be made after the same patterns. The slots in all the armature laminations would have the same width and depth.

These conditions, if existing, would greatly cheapen the cost of manufacturing dynamos, therefore the prices charged to the purchaser.

The steam engine stands in the way of accomplishing these results. The speeds and capacities of engines have been established by their makers without reference to the best conditions for the successful operations of the generators they are to drive.

For the smaller dynamos, as you will see by the table given above, speeds of from 300 to 800 revolutions per minute are permissible and entirely proper, but when the larger capacities are reached, the speed must be lowered in order to obtain good performance, especially for traction generators. I hope, therefore, that the builders of engines and manufacturers of direct current generators will co-operate in establishing a satisfactory scale of speeds and capacities for steam dynamo sets.

In the discussion which followed,

Mr. H. A. EARLE said that formerly with small generators 200 or 300 H.P. were alone required, but the engineers were calling for more speed and the generator makers responded. Now the size of generators was increasing. A very large demand had sprung up for large generators, and it was a most important point that contracts should not be undertaken for speeds of generators in excess of those which could be satisfactorily built. Builders had given the matter a very great amount of thought, and had got their patterns, and were unwilling to change. But now they were beginning to find that it was unwise to build generators of 1,500 KW. and running at 200 revolutions. Cheap builders and cheap plant seemed to be what was required at the present time, and he thought that it was a great mistake for builders to refuse to build machines at a high speed. If they did, dynamo makers who had not had their experience, would say, "We will do it." Those who put up plant would be asking for a slower speed, and a slower speed would be given, but it would very unwise to go on in that way. It would mean a loss of speed, a loss of reputation and a loss of money. They must remind builders that a generator was not a machine in which the mechanical question alone limited speed. Mr. Short had laid down a set of figures which gave the best results. The width of the bar, and the number of the brushes depended on the tender. The number of poles was limited by periodicity, and the number of bars would be dependent on the number of poles. Taking those points together, there were many points which they met with; he thought that standardising would be a very good thing indeed. There was no doubt that some of the speeds now were too high, and those who had experience did not like the call for speeds, and those who had not had experience were ready to quote for any speed. He thought that a conference between consulting engineers and generator makers would be a very good thing indeed, and that some agreement would be arrived at. He wanted to ask Mr. Short with regard to the connected equal potential points round the armature. It was not usual in England, and he would like to ask him if it was usual in the States?

Major P. CARDEW said that Mr. Short had brought forward some very important points for consideration. He certainly had not considered the difficulty of dynamo makers as regards speed. They were of opinion that the difficulties resided more in the engines than in the dynamos. Of course, it was merely for want of consideration, but when they had had to do with dynamos the fact was forced upon them. He considered that Mr. Short had a great deal of solid fact in his ideas as regards the specifications of dynamos. He (the speaker) thought it should be known that it was the dynamo makers who asked for moderation in those machines. Certainly the time was coming when large machines would be the rule. A great deal of money had been spent in England in designing stations which only lasted a year or so, and if those stations grew as they should, they found themselves saddled with half a dozen machines and with plant nothing like the size of the next unit which had to take its place. He thought it was best in designing a station to use a little boldness and not to start with those very small units.

Mr. J. D. BAILEY said there was only the question of speed to which he would refer. He agreed that the speed of dynamos should be moderate instead of very high in large-sized plant, and it probably would be. But it would hardly be limited in any way by the engine, as the engine speed could be very high.

Mr. B. S. GILES remarked that the most important thing to say was on the question of speed. It was a most important and debateable question. He dared say that in America it was not so debateable, as it had not forced itself upon them. Of course, consulting engineers wanted speeds as high as they could get them. But the first thing to consider was satisfactory working. If a dynamo were not working satisfactorily, it did not matter how cheap it was; it was unsatisfactory. For that reason he thought those high speeds should not be put in, especially the very high speeds. He thought dynamos were always larger than they needed to be. A dynamo was always larger than the engine to start with. Then it was asked to stand 25 per cent. overload for two or three hours; then 50 per cent., and then 100 per cent. overload continuously. Incidentally, he would like to raise a point as to the way in which consulting engineers arranged their specifications. They found that often they did not know what they wanted. They read through the specifications and found that they adopted a voltage, but it was very difficult to find out what the guarantee was. He could not see why they could not have it definitely stated what they wanted on the normal line and the overloads. It would save a lot of trouble. As regards Mr. Short's speeds he thought they were rather low, quite 10 per cent. lower than they could be carried out. It was very good if they took the standard point of 550 volts for their base, but they had to make the same machine do a variety of voltage; 220 volts was often asked for, and they naturally wanted to be able to see the same machine for those different outputs, and that did affect the complete standardisation of machines. He thought Mr. Short's paper was an excellent paper, as giving them a good base for standardisation.

Mr. J. FRITH shared with Mr. Giles the difficulties as to what was wanted in specifications. With regard to speeds, he thought that sufficient care was not taken to consider what was going on

inside a dynamo. The brush should be able to stand a little vibration without sparking, and would do it if the internal condition of the commutator were easy as it should be.

Mr. Whitmore and Mr. Cooper also spoke briefly on the subject of speed.

The Chairman asked Mr. Short to refer in his reply to two points. He had shown a slit across the centre of the pole fields. They all knew the object of that, but he thought that very few of them knew whether the objects the designers had in putting in that slit had been attained in practice. The next point was the question of connecting equal potential points round the armature. Mr. Short alluded to that as general practice. As far as his (the chairman's) experience went, it was unusual. He hoped Mr. Short, in replying, would refer more fully to that point.

Prof. Short replied at length, and in detail, making drawings on the blackboard to explain various points raised, and points of difficulty in practical working and showing how they had been overcome. In their machines, he said they wanted to get rid of magnetic reluctance, and get just as little resistance as possible. With regard to cross-connecting, to which the chairman and other speakers had referred, the machines he (Prof. Short) remembered were cross-connected all round. It was the usual practice. As regards the slot across the pole face, they did not use that for any good it did. They used to use a slit in the pole face, he thought that nearly all makers used it, but he did not think it did any good. With respect to speeds, he thought they should run machines at moderate speeds, but he did not want them to think that they could not build a machine which would run at higher speeds. He wanted to bring out that there was a limit beyond which they dare not go, and live comfortably and sleep well every night.

On the proposal of the Chairman, a very cordial vote of thanks was accorded to Prof. Short for his paper.

CURRENT SPECIFICATIONS.

LVI.—SOUTH LANCASHIRE TRAMWAYS.

Summary.

Extent of Contract.—Supply of not less than 50 or more than 70 completely equipped electrical tramcars.

Division of Contract.—Separate offers are invited for car bodies and trucks and also for electrical equipments.

Type of Car.—To be of the double-deck type with reversed staircase, of the general design shown on tracing issued with specification.

Gauge of Line.—4 ft. 8½ in.

Seating Accommodation.—55 in all, 22 inside, and 33 outside.

Wheel Base of Truck.—6 ft.

Diameter of Wheels.—2 ft. 6 in.

Type of Truck.—Trucks of either "Peckham" or "Brill" type must be included in main offer, but an alternative tender may be made for trucks by other makers.

Type of Truck.—To be of the usual four-wheel standard type.

Specified Maker of Wheels.—Either Messrs. Miller & Co., of Edinburgh, New York Car Wheel Works, or other approved maker.

Specified Tensile Strength of Axles.—Not less than 65,000 lbs. per square inch with 20 per cent. elongation in a length of 8 in.

Hand Brake Gear.—To be fitted to each car, design to be in accordance with Board of Trade requirements, of latest type.

Life Guards.—To be supplied to each car of a type approved by Board of Trade.

Specified Type of Motors.—To be of Thomson-Houston, Westinghouse, or other approved type.

Specified Capacity of Motors.—The two motors mounted on each car to be capable of easily propelling the car fully loaded at a speed of 5 miles per hour up a gradient of 1 in 15.

Maximum Speed of Motors.—To be 10 miles per hour on a gradient of 1 in 50.

Specified Flashing Test for Motors.—For armature 2,500 volts between windings and core; for commutator 5,000 volts between segments and shaft, and 500 volts between adjacent segments. Voltage to be alternating in each case.

Type of Controllers.—To be of series parallel type embodying magnetic blow-out principle, and fitted with electrical emergency stop.

Type of Trolley.—To be of latest improved pattern, side-swivelling type, with internal springs, and to be of Messrs. R. W. Blackwell & Co.'s make.

Type of Lightning Arrester.—To be of Wurt's or magnetic blow-out type.

Specified Date of Delivery.—Fifty complete cars to be delivered by December 31st next.

Penalty for Late Completion.—One half of 1 per cent. of the gross value of the contract for each week or part of week.

Option of Purchasers as Regards Delivery.—The purchasers may suspend the date of delivery at their option until any period previous to October 31st, 1902. If the additional 20 cars are ordered, an extension of three months on the above-specified date to be given.

Specified Terms of Payment.—Eighty per cent. on delivery, 10 per cent. within one month of acceptance by purchaser; 10 per cent. six months later.

Specified Period of Maintenance.—Six months from date of putting into use.

Sureties Required.—Two, to be responsible jointly and severally in a sum equal to 15 per cent. of value of contract.

Stipulations as to Removal of Foreman.—Satisfactory.

Stipulations as to Wages paid to Workmen.—None.

Arbitration Proposals.—Unsatisfactory; see comments below.

Date for Receipt of Tenders.—April 20th, 1901.

The specification for this work has been drawn up by Messrs. Kincaid, Waller & Manville, who are acting as consulting engineers in the matter to the directors of the South Lancashire Electric Traction and Power Company, Limited, of Liverpool.

The cars are required for use on the extensive network of electric lines which will eventually connect the environs of Manchester and Liverpool with the busy towns *en route*.

The company have acted wisely in deciding to adopt one type of car as their standard for use on all their lines, as by so doing they will be in a more favourable position to buy cheaply, and also minimise the number of spare parts which they will need to keep in hand.

It will be noticed from the above summary that a thoroughly serviceable type of car is required, with a large seating capacity for its size, and that the now fashionable reversed pattern of staircase is specified. The trucks tendered for *must* be of either "Brill" or "Peckham" type, but it is open to tenderers to offer other makes of trucks as an alternative.

In the same manner, while preference is expressed for motors of either Thomson-Houston or Westinghouse type, the saving clause "or other approved type" is now inserted. This is an improvement on other specifications for electrical equipments which have come under our notice where the choice of make of motor has been very restricted.

Powerful hand brakes are specified for the trucks, and in addition electrical emergency brake arrangements on the controllers.

The specified date of delivery for 50 complete cars is December 31st, 1901, and the specification goes on to say that delivery may be deferred at the option of the purchaser until October 31st, 1901. We have taken this as a misprint for October 31st, 1902.

The chief feature of the general conditions needing special attention at the hands of the tenderers is the unsatisfactory provision for arbitration is cases of dispute. If on any point the contractors and purchasers find themselves unable to come to a satisfactory agreement, the matter is to be referred to the engineers, "whose decision shall be binding upon the contractors." This policy we hold to be unjustifiable, as it places the onus of deciding upon a party who is the paid agent of one of the disputants. Such an arrangement is unsatisfactory from many standpoints, but we conceive it to be most unfair to the engineers, who are thus placed in an invidious position they ought not to be called upon to fill. In our opinion it should be an invariable rule in all commercial contracts that either party to the contract should have, in case of dispute, as a final resort, the right to place the matter in the hands of an entirely independent arbitrator. Any so-called arbitration proposal which does not embody this principle should be protested against, no matter how fair-minded and high-principled the particular firm thus appointed final referee may be.

LONDON COUNTY COUNCIL.

The Council at last week's meeting decided to advance £10,000 to the Stepney Borough Council for electric lighting purposes.

Electric Traction.—Among the questions raised on the motion for the reception of the report of the Highways Committee was one by Earl Russell, who asked the chairman whether he had read the criticisms of the press on Prof. Kennedy's form of conduit. In reply, Mr. J. W. Benn stated that he was informed that Prof. Kennedy was quite able to meet the criticisms. Meanwhile the Committee had attached sufficient importance to the criticisms to collect and forward them to the consulting engineer for report to

the Committee. The chairman of the Committee, replying to Messrs. Gilbert, Baines and H. Williams, stated that it would be necessary to arrange another meeting at Camberwell in order that the new members of the Council might inspect the proposals for the development of electric traction. The type of car at the Camberwell depôt was pretty much the same as the Committee would recommend to the Council. As to whether the system had been finally settled upon, it could not be final until the Board of Trade had expressed an opinion upon it. Until that had been done Prof. Kennedy would doubtless accept any suggestions to improve his system.

Electric Lighting Orders.—The Council decided last February to again suggest to the Board of Trade that in the provisional orders of the present session the maximum price to be charged to consumers should be fixed at 5d. per unit instead of 8d. as in previous orders. In this connection the Highways Committee referred to the Board of Trade inquiry recently held in regard to the matter, and to the statement of Sir Courtenay Boyle that a 7d. maximum would be adopted as the normal rate in ordinary cases, and 6d. per unit in large populous places. The Committee, in commenting upon the subject, expressed the opinion that the decision of the Board was a satisfactory result of the Council's efforts in that direction.

With regard to the order applied for by the St. Marylebone Borough Council, the Highways Committee mentioned that the suggestions made by the Council have been adopted by the Board of Trade, and the maximum price per unit, after the first 20, which are to be paid for at the rate of 7d., has been fixed at 6d. The Council suggested to the Board of Trade that the application of the Marylebone Electric Supply Corporation for an order should not be entertained, or that, if allowed to proceed, certain amendments should be made in it, and most of these have been adopted. The Board has intimated that, after full consideration of the circumstances, it has decided to grant both the orders referred to, and to leave to Parliament the decision of the question whether any, and if so what, supply of electricity is to be authorised in the borough in competition with the supply now given by the Metropolitan Electric Supply Company. Both the orders have been inserted in a Confirmation Bill.

Wiremen v. Carpenters.—The report of the General Purposes Committee reminded the Council of the recent reference to consider the advisability of amending the standing orders as to contracts in order to provide that the trades to be employed in the more important sections of any works to be carried out under contract, should be specified in a schedule to be added to the contract. The question had been raised by the Asylums Committee who had experienced difficulty at the Horton Asylum in consequence of the casing and capping in connection with the electric lighting installation being fixed by wiremen, whereas the Amalgamated Society of Carpenters and Joiners claimed that the work should be done by carpenters. At the time the Asylums Committee stated they had asked the contractors to employ carpenters for the work, but in the absence of any stipulation in the contract, they had declined to do so, and the Committee were unable to insist upon the contractors complying with the request. To meet similar cases in the future, the Committee had made the suggestion that it would be well to specify in contracts the trades to be employed in the more important sections of the work for the carrying out of which the contract was arranged. Having fully considered the question, the General Purposes Committee expressed the opinion that it would be inexpedient to amend the standing orders in the direction suggested, and they submitted a recommendation accordingly.

Mr. G. Dew proposed, in the interest of electrical workers, that the recommendation should be referred back to the Committee for further consideration.

Mr. H. R. Taylor seconded the amendment, because he considered that the trade unions concerned should have an opportunity of stating their views before the Committee.

Mr. J. Burns said the question was one of serious principle, not affecting one trade only, but sometimes as many as 100 trades, which might be included in a contract schedule. If the Council gave preferential treatment to two trades as to the line of demarcation, they would be establishing a precedent of which they would one day probably see the folly. If the Council stipulated in the schedule the type of trade and class of trade which should do a certain class of work, they would be departing from the principle laid down in the standing orders with regard to labour, which was that contractors were required to observe the hours of labour and rates of wages which in practice obtain and were agreed upon between the masters and the men themselves. The employers and the men should draw the line of demarcation, and when they had agreed upon that the Council would have no difficulty in adjusting their contracts to it. But if the Council specified the trade, they would embark upon a sea of trouble of which no one could see the end. He suggested that all the London trades should adjust their differences together.

Mr. E. A. Cornwall, acting chairman of the Committee, expressed the hope that the Council would not send the recommendation back. The Committee had found it quite impracticable to do as was suggested by the Asylums Committee, and he understood that that Committee was now satisfied with the recommendation, and did not desire to press the point. The speaker contended that they would not be consulting the interests of the other trades unions or of the Council if the question was allowed to remain open.

After some observations by Lord Welby and Messrs. H. Williams and H. Gosling the amendment was put, when eight votes were received in its favour and the remainder against it. The amendment was therefore rejected and the recommendation was then agreed to.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

6,191. "Improvements in electric light and power appliances." R. L. Wood. March 25th.

6,207. "Improved method of and means for automatically switching off the current in trolley wires used for electric traction in case of a breakage or other accident." R. Swales, F. Stamford, and R. A. Swales. March 25th.

6,242. "Improvements in or connected with electric demand indicators." W. Cowderoy. March 25th.

6,246. "Process for the application of metallic coating to plates and any desired material, framed or otherwise for the permanent fixation of photographs." C. P. H. Ahrle, The Mettalline Plattem Gesellschaft m. b. h. March 25th.

6,258. "Improvements in electrical switches and like contact devices." J. J. Glass. March 25th.

6,271. "Improvements in or relating to telegraphic or telautographic apparatus." A. J. Boult. (E. C. Gruhn.) March 25th.

6,280. "Improvements in electrical controller switches for electric circuits." A. Eckstein and D. B. Mellif. March 26th.

6,317. "Improvements in apparatus for the manufacture of electrical insulating material, and for the testing of the insulation of electric conductors." E. A. Claremont. March 26th.

6,327. "Improvements relating to insulated joints or connections for railways and similar rails." H. H. Lake. (The Weber Railway and Joint Manufacturing Company, United States of America.) March 26th.

6,352. "Improvement in electric accumulators." B. M. Drake and J. M. Gorham. March 26th.

6,358. "Improvements in or relating to electric ignition devices for internal combustion engines." A. F. Aldridge and C. M. Linley. March 26th.

6,363. "Improvements in electric accumulators." A. Carter. March 26th.

6,370. "Improvements in electrical means for preventing collisions on railways, tramways, and the like." J. Wanner and F. Wanner. March 26th.

6,388. "Improvements in protectors for overhead electrical tramway wires." L. Cooper. March 27th.

6,393. "New or improved means or apparatus to be employed in or for the covering or fixing of roofs to the tops of electrical tramcars." C. H. Wilkinson. March 27th.

6,396. "Improvements in telegraph apparatus." O. A. Berend. March 27th.

6,403. "Improvements in automatic electric circuit breakers." A. Eckstein and D. B. Mellis. March 27th.

6,445. "Improvements relating to switch mechanism, more especially applicable for use in electric motors." H. Lamm. March 27th.

6,454. "A new or improved grid or electrode for retaining plumbic oxides in accumulators to prevent disintegration during charging and discharging." E. J. Clark. March 27th.

6,460. "Improvements in electrical signalling appliances for steam, electrical, and other railways." R. Bartelmus. March 27th.

6,531. "Improvements in electric ignition devices for explosion motors." B. M. Turner and R. T. Smith. March 28th.

6,554. "A new or improved means of varying the current in electromotors." C. A. Carus-Wilson and E. H. Tyler. March 28th.

6,587. "Improvements in watertight electric bells." A. Eckstein and H. J. Coates. March 29th.

6,594. "A new and improved method of and apparatus for connecting electrical wires or conductors." W. H. Weguelin. March 29th.

6,597. "Improvements in apparatus for use in wireless telegraphy." S. G. Brown. March 29th.

6,615. "Improvements in arc lamps." H. Bremer. March 29th.

6,617. "Improvements in charging devices for electromobiles." The British Thomson-Houston Company, Limited. (C. D. Haskins, United States.) March 29th. (Complete.)

6,620. "Improvements in drying electric cables and other goods, and in apparatus therefor." G. E. Heyl-Dia. March 29th.

6,634. "Improvements in and relating to automatic magnetic circuit breakers." W. R. Lake. (W. M. Scott, United States.) March 29th.

6,635. "Improvements in and relating to automatic magnetic circuit breakers." W. R. Lake. (W. M. Scott, United States.) March 29th.

6,645. "Relay for telegraphic purposes." C. A. T. Jensen and H. S. R. Sieveking. March 29th.

6,648. "Improvements in the process of electrically pulverising metals." W. Longman. (P. Bary, France.) March 29th.

6,649. "Improvements in heater cut-outs and holders for electrolytic incandescent lamps." W. Hooker. March 29th.

6,660. "Improved double-action electric bell." B. Brander. March 30th.

6,668. "Improvements in electrical measuring instruments." Crompton and Co. Limited, and W. A. Price. March 30th.

6,720. "Improvements in means for driving dynamo-electric machines." A. A. Jordan and A. C. Oakes. March 30th.

6,723. "Improvements in means for applying the active material to the plates of secondary batteries." T. Pescatore. March 30th.

6,739. "Improvements in and connected with the distillation or utilisation of tar, pitch, petroleum and other hydro-carbon mixtures, and the extraction of carbon suitable for the manufacture of electrodes, calcium carbide, and other industrial products." L. Gastar. March 30th.

6,749. "Improvements relating to insulating substances." G. Korner. March 30th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

10,863. "Improvements in switches for alternating electric currents." B. Hopkinson. Dated May 24th, 1899. Switches and cut-outs for alternating currents are so arranged that contact is finally broken when the current is approximately at zero value. An electro-magnetic switch is arranged in shunt with the main switch, the armature and core forming the contacts. When the main switch is opened, the armature is held by the magnet until the current sinks to zero, when the armature is pulled off by a spring. One form comprises an

adjustable electro-magnet and an armature sliding in a case. The armature is connected by a flexible wire with a sliding cylinder connected to a spring which tends to lift the cylinder and armature. When the main switch is closed, the cylinder is pressed down by a bar and locked in that position by a rod connected to a lever which in turn is connected to the switch lever by a string. When the main switch is opened the rods are drawn away from the cylinder, and the armature is then held down only by the magnet. When the current sinks to zero, the spring draws off the armature, so completely breaking the circuit. A condenser may be arranged to prevent sparking between the armature and magnet. In the modification adapted for a quick-break circuit-breaker, the armature is normally pressed against the magnet by a spring surrounding a tube, while a spring within the tube tends to withdraw the armature. When the main switch is opened, a fork compresses the spring and allows the spring to operate. With very high potential circuits, several shunt switches may be arranged in connection with a main switch. 6 claims.

10,303. "Improvements in telegraph transmitter and receivers." W. L. Wise. (A. C. Crehore.) Dated May 24th, 1899. Relates to a system of transmitting from perforated messages and receiving by means of a record on a chemically-prepared paper. The messages are prepared and received in lines arranged transversely to a web of paper. Continuous or alternating currents may be employed, but preferably the system of transmission is adopted as described in Specification No. 6,787, A.D. 1897. 11 claims.

10,336. "Improvements in controllers for electric motors." R. Belfield. (H. P. Davis.) Dated May 16th, 1899. A controller for electric railway motors is provided with a separate circuit making-and-breaking switch for automatically breaking the circuit before the connections of the motors can be changed from series to parallel, or when the controller is moved backwards. One form of the apparatus, in which is the controller drum, the drums of the combined reversing and cut-out switch, the series switch for making and breaking the circuit is described. The three drums referred to carry contact strips acted on by stationary contacts in the manner shown. The controller drum is mounted loosely on the operating shaft, and is connected thereto by means allowing of a certain amount of lost motion or play between the said drums and shaft. It carries at its lower end a notched plate acted on by a spring pawl whereby the drum, after being rotated a certain amount, is caused to move quickly and in advance of the shaft through the next portion of its path. On the operating shaft are fixed a cam and a second notched plate and these co-operate with the head of a rocking shaft, which imparts motion by a toothed segment and pinion to the shaft of the make-and-break switch. The head of the rocking shaft is provided with a pair of pivoted spring pawls and a rigid projection, these being adapted to engage with the cam and notched plate in such a manner as to actuate the make-and-break switch at the proper moment. In one form of the apparatus the make-and-break switch consists of a pair of spring contact arms, moving over a series of pins in connection with resistance coils. A modified form of the apparatus is described, in which the contacts of the make-and-break switch are arranged in a closed box filled with a suitable liquid, such as glycerine. The shaft of the switch is connected to the controller shaft through a friction clutch, which is operative while the controller is varying the resistance in circuit, but inoperative while the motors are being changed from series to parallel, at which time the circuit is broken by the action of a spring. 6 claims.

10,536. "Improvements in and relating to electrical contact devices for explosion engines fired by electricity." J. G. Accles. Dated May 18th, 1899. Igniting:—The timing of the ignition is effected by adjusting a fixed contact relatively to a rotating helical one. The contact can turn about a spindle or side parallel to the shaft, or it may be immovable, and the contact may be slid on its shaft. The contact may be a helical strip flush with the insulated drum, or a projection from a metal drum as shown. The spindle is turned by a handle placed conveniently near the driver. 2 claims.

10,608. "Improvements in the manufacture of conduits for electrical conductors and other purposes, and in apparatus therefor." H. S. Morrison. Dated May 19th, 1899. Material is placed in a mould, the hinged lid is closed and fastened by cottars or otherwise, and the material is compressed by a plunger which works within the mould on tubular call-rods, and is connected by rods to a hydraulic or other ram. The outer end of the mould is hinged, and is turned back to allow the multitubular conduit to be forced out of the moulds along the call-rods by the plunger. A metal plate at the bottom of the mould serves to carry off the conduit when it is forced out on to carrier rollers. The plunger and outer end of the mould are shaped to produce a conduit with spigot-and-socket ends. Centres or projections of the end door enter, and support the loose ends of the call-rods. 3 claims.

10,682. "Improvements in telephone appliances." J. D. F. Andrews. Dated May 20th, 1899. Telephonic apparatus is arranged to call and connect any one of a number of subscribers by inserting or pressing a plug in connection with that subscriber into or against a bar, plate, &c., connected with home instruments. When the plugs pass into a plate, &c., a locking-action is obtained. The plug is provided with a locking-cone for engaging in one of the eccentric openings in the disc. The plug may be released by the insertion of a second plug or by the additional cone, which brings the openings in the disc into line with the plug sockets. When the openings in the plate are in a line, the plugs may engage obliquely. The arrangements may be applied to hand and fixed telephones. 6 claims.

11,166. "An improvement in electrolytes for deposit of metals." P. Marino. Dated May 29th, 1899. Electrolytes: Metals, depositing:—Electrolytes for depositing metals, especially zinc, lead, tin, copper, silver or nickel or alloys of these metals, upon iron, cast-iron, steel, and other metals, are formed by mixing two solutions, the first a solution of the salt of the metal or metals to be deposited in a neutral ammonium-tartrate solution, and the second a mixed solution magnesium sulphate and sodium pyrophosphate. A small quantity of ammonium carbonate is added to the solution before use. The electrolytic solution may also be used for coating zinc with tin by simple immersion. 1 claim.

11,172 "An improved apparatus for controlling electric currents especially applicable for charging secondary batteries or accumulators." Veritys, Limited, and L. J. Steele. Dated May 29th, 1899. Apparatus for breaking the circuit should the charging-current fall below the necessary voltage. An oscillating carrier carries switch contacts and a permanent magnet. It is supported on knife edges and one end is weighted. An electro-magnet having two poles is wound with two coils, one having a low resistance and the other a high. The coil is connected to the mercury cup and terminal, and the coil to the cup. The other terminal is connected to the oscillating carrier. The charging-circuit is connected to the battery through the low resistance coil. Should the current fall, or a reverse current flow through the coil, the carrier oscillates, breaking contact with one pole and making contact with the other pole, so completing a circuit through the high resistance coil. When the voltage again rises, this coil excites the magnet, causing the magnet to swing over and again make the main circuit. The contacts are adjustable, the coils of the electro-magnet are preferably mounted in a copper spool. 5 claims.

11,227. "Improvements in the ventilation of electro-motors, dynamos, and the like." J. P. Hall. Dated May 30th, 1899. Cooling and ventilating. The armature of an enclosed electric motor or dynamo is constructed so as to act as a fan, being provided with a number of annular air-spaces containing vanes and communicating with one another by longitudinal passages. Air is drawn in at one end of the machine through a chamber, and, after passing through the armature and casing is expelled at the opposite end through a chamber. 2 claims.

11,244. "Improvements for compounds for battery solutions." H. Blumenberg, jun. Dated May 30th, 1899. Relates to compounds which, when dissolved in water, form battery solutions, and particularly to those adapted for use in one-fluid cells of the zinc-carbon type. The compound consists of a mixture of aluminium sulphate with a chlorate and a bi-sulphate of an alkali or alkaline-earth metal. The compound preferably employed consists of a mixture of aluminium sulphate, sodium bi-sulphate, and sodium chlorate. The aluminium sulphate may be replaced by one of the alums. 3 claims.

11,325. "Improvements in or relating to electric traction." A. Bochet. Dated May 31st, 1899. Relates to electric traction of cars running on rails, and especially to the system in which the current is conveyed underground from the central station into overhead contacts arranged at intervals along the line in such manner as to keep each car, or train of cars, in permanent communication with the source of electricity. The invention mainly consists of means for allowing for the vertical movement of the car on its spring, and of means for enabling this system to be used with trains of cars. A flexible conductor extends the length of the car and is supported on suitably-mounted springs at such a height that its resilience keeps it always touching one or another of the roller contacts carried by standards and connected with the conductor in the conduit. In the case of trains of cars, in one form the several standards are each furnished with double brackets carring two contacts at a distance from each other slightly in excess of that between the cars. In another form, the collector is made continuous throughout the train, but is mounted so as to permit of running round curves without subjecting it to strain. The conductors are flexible, and are carried by springs as before, but the springs are attached to a cross piece and bars suitably pivoted to the cars. 4 claims.

11,345. "Improvements in cartridges to be fired by electricity." W. Friese-Greene and P. E. Knell. Dated May 31st, 1899. Relates to cartridges for blasting purposes, or for use in guns, and a gun for firing such cartridges. The ordinary explosive is replaced by a substance such as magnesium, lead, tin, or tin alloy, employed in the form of twisted wire or shavings, which is vapourised by the passage of an electric current. In the blasting cartridge a series of magnesium strips are carried in an insulated case, and are connected at one end by metal pins and wires to a terminal, and at the other end by a metal plate and wire to a second terminal. Upon connecting the terminals to an electric battery, the strips of magnesium are vapourised and the cartridge exploded. In another blasting cartridge metal bars carried in an insulated case are alternately connected by wires to two terminals, while the magnesium is carried as a wire coiled round the rods or in the form of thin discs threaded on the rods. When this form of cartridge is employed in a gun for propelling a projectile, the terminals from the cartridge make contact with the conductors on the breech-lock. This breech-lock is pivoted beneath the gun, and is held in position by a bridle piece, which is pivoted to the gun and is provided with a locking screw. 5 claims.

11,374. "Improvements in apparatus for lighting miners' safety or other enclosed lamps by electric currents." J. Warrington and E. Brown. Dated June 1st, 1899. Relates to electrical apparatus for igniting miners' safety and other enclosed lamps without opening the casing or lantern. The lamp, after it has been cleaned, trimmed, and locked, is so placed upon the metallic plate of a non-conducting stand that a metallic conductor, which is insulated in the lamp glass, is located opposite to a sliding contact on the stand. When the lamp is pushed forward, the piece pressing the slide on to an insulating pad on the spring completes the primary circuit by making contact between the said spring and an adjustable screw. A spark from the induction coil then passes between the part and the wick tube and ignites the wick. The invention may be adapted to existing lamps. 2 claims.

11,418. "Improvements in electric arc lamps." B. H. Pomeroy. Dated June 1st, 1899. Arc lamps. The upper carbon is secured by a screw clamp in a slotted holder which slides in a fixed tube, a flexible conductor and the head of the clamping-screw projecting through a slot in the tube. The tube is insulated from the lamp frame, and the holder from a supporting chain which passes over a chain wheel and is weighted at its other end. The chain wheel carries ratchet teeth to engage a pawl pivoted in slots in a frame, which can turn on the wheel axle, the pawl being weighted to keep it vertical. The pawl is movable towards or from the ratched teeth by a slotted lever, which is pivoted in and acted on by a spring on the frame, and is linked to a core below a series solenoid or other electro-magnetic device. Passage of current through the solenoid raises the core and causes the lever to hold the pawl against the ratchet teeth and turn the wheel to strike the arc. Feeding occurs when the frame descends on an adjustable stop so that further descent of the core and link withdraws the pawl from the ratchet teeth. Upward movement of the core is controlled by a connected piston moving in a stationary dash-pot; a lift-valve in the piston permits free downward movement. The stationary lower carbon holder is insulated from the lamp frame, which is not electrically connected with the circuit. An arc-enclosing globe, having a detached cover, is fixed in a socket adapted to fit upon a conical shoulder on the lower carbon holder. When alternating current is used, a divided choking coil is provided in the lamp casing. This consists of angular iron cores bolted together on distance pieces and wound with coils, which are connected by clamps so that any number of them may be joined in series with the carbons. 5 claims.

11,424. "Improvements in accumulator batteries." P. Marino. Dated June 1st, 1899. Each positive electrode is a thin sheet of lead, flat, or corrugated, and preferably perforated with numerous holes. It is covered with a layer of minium or a mixture of minium and graphite rendered fluid and adherent by a liquid consisting of water, gun-cotton, and caustic soda or potash, to which benzene may be added to remove grease from the metal. The negative electrode consists of a similar plate of lead, aluminium, or other metal covered like the positive electrode but with litharge instead of minium. The plates are arranged in an horizontal manner with porous rigid partitions of asbestos, unglazed porcelain, magnesia paste, &c., between them, and the plates thus arranged are tied together in bundles. The plates are formed by first treating them with an electric current, while they are immersed in a double sulphate of lead and ammonia, which is obtained by precipitating lead acetate by sulphuric acid, and saturating the excess of acid with ammonia. The plates are finally formed in a solution made by adding sugar and water to the glycerate of calcium, barium, or strontium. The electrolyte used in the battery consists of an aqueous solution of phosphoric or other oxy-acid of phosphorus, to which a few drops of hypophosphorus acid are added. 4 claims.

11,436. "Improvements in rheostats." C. Flohr and R. Dietze. Dated June 1st, 1899. A box contains a resistant powder and a plate connected to one terminal, and carries externally an insulated strip connected to the other terminal. An insulated shaft carries arms inside and outside the box, so that when it is turned the outside arm first makes contact with the strip and the inside arm then moves into the powder until it bears on the plate. The object is to stop leakage of current through powder resting on the insulation when the arm is withdrawn. 2 claims.

11,445. "Improvements in electric circuit breakers." H. P. Davis. Dated June 1st, 1899. (Date under International Convention, November 4th, 1898.) Cut-outs are so arranged that, when the fuse wire melts, the terminals shall separate to a considerable extent and so prevent arcing. Means are provided for detaching the circuit-breaker for inspection, &c. In one form a fuse wire connects terminals, the latter being carried by a bar hinged to a bracket. A spring forces the bar into the position, when the fuse melts. The other terminal is carried by a rod which is removably hooked on one of the line terminals. The rod is also secured by clips to a projection on the support. A conductor connects the line terminal with the terminal. The fuse is clamped in the terminal between a fixed jaw and a movable jaw. A cord is connected to this jaw so that the fuse wire may be liberated when it is desired to remove the circuit breaker. 4 claims.

11,446. "Improvements in systems of electrical distribution." C. F. Scott. Dated June 1st, 1899. (Date under International Convention, November 4th, 1898.) Relates to arrangements for obtaining three-phase currents from two pairs of leads carrying currents in quadrature. The armature of a polyphase generator has two terminals connected to the line wires; the other terminals are connected to the primary coil of a transformer. The secondary is connected to one of the terminals of the primary and to the line wire. The coils of the transformers are so proportioned as to produce the desired difference of electromotive force and phase. 1 claim.

11,447. "Improvements in or relating to electric cables." G. E. Hoyl-Dia. Dated June 1st, 1899. Conductors are insulated with strips of paper such as described in Specification No. 2,610 A.D. 1899, or paper saturated with oxidized oil. The strips are put on by ordinary methods. Layers of india-rubber, gutta-percha, pitch, &c., vulcanised or unvulcanised, may be employed between some of the layers of paper. A metal sheath may also be employed. 2 claims.

11,552. "Improved electric tumbler switch." H. J. T. Voigt and J. A. Haeffner. Dated June 2nd, 1899. The movable contact of a tumbler switch is carried by a pair of bars pivoted on the pin, on which is also pivoted the handle. Pivoted on a pin connected to the bars is a slotted bar, in the slot of which works a pin carried by the forked lower end of the handle. A spring surrounds the bar, and presses against the end of the handle. To break the circuit the hand e is moved in the direction of the handle, compressing the spring until the dead point is reached, when the contact and bars are forced back. 2 claims.